Ohio | Public Utilities Commission

Application to Commit Energy Efficiency/Peak Demand Reduction Programs (Mercantile Customers Only)

Case No.: 13 - 1540 **-EL-EEC**

Mercantile Customer: Whirlpool Corp.

Electric Utility: Ohio Edison Company

Program Title or Description: Compressed Air and Wet-Paint Chilled Water System Upgrades

Rule 4901:1-39-05(F), Ohio Administrative Code (O.A.C.), permits a mercantile customer to file, either individually or jointly with an electric utility, an application to commit the customer's existing demand reduction, demand response, and energy efficiency programs for integration with the electric utility's programs. The following application form is to be used by mercantile customers, either individually or jointly with their electric utility, to apply for commitment of such programs in accordance with the Commission's pilot program established in Case No. 10-834-EL-POR

Completed applications requesting the cash rebate reasonable arrangement option (Option 1) in lieu of an exemption from the electric utility's energy efficiency and demand reduction (EEDR) rider will be automatically approved on the sixty-first calendar day after filing, unless the Commission, or an attorney examiner, suspends or denies the application prior to that time. Completed applications requesting the exemption from the EEDR rider (Option 2) will also qualify for the 60-day automatic approval so long as the exemption period does not exceed 24 months. Rider exemptions for periods of more than 24 months will be reviewed by the Commission Staff and are only approved up the issuance of a Commission order.

Complete a separate application for each customer program. Projects undertaken by a customer as a single program at a single location or at various locations within the same service territory should be submitted together as a single program filing, when possible. Check all boxes that are applicable to your program. For each box checked, be sure to complete all subparts of the question, and provide all requested additional information. Submittal of incomplete applications may result in a suspension of the automatic approval process or denial of the application.

Any confidential or trade secret information may be submitted to Staff on disc or via email at ee-pdr@puc.state.oh.us.

Section 1: Mercantile Customer Information

Name:Whirlpool Corporation

Principal address:1300 Marion Agosta Rd. Marion OH 43302

Address of facility for which this energy efficiency program applies:1300 Marion Agosta Rd. Marion OH 43302

Name and telephone number for responses to questions:David Freyhof (740-383-7188)

Electricity use by the customer (check the box(es) that apply):

- ☒ The customer uses more than seven hundred thousand kilowatt hours per year at the above facility. (Please attach documentation.)
- ☐ The customer is part of a national account involving multiple facilities in one or more states. (Please attach documentation.)

Section 2: Application Information

A) The customer is filing this application (choose which applies):

- ☐ Individually, without electric utility participation.
- ☒ Jointly with the electric utility.

B) The electric utility is: Ohio Edison Company

C) The customer is offering to commit (check any that apply):

- ☐ Energy savings from the customer's energy efficiency program. (Complete Sections 3, 5, 6, and 7.)
- ☐ Capacity savings from the customer's demand response/demand reduction program. (Complete Sections 4, 5, 6, and 7.)
- ☒ Both the energy savings and the capacity savings from the customer's energy efficiency program. (Complete all sections of the Application.)

Section 3: Energy Efficiency Programs

A) The customer's energy efficiency program involves (check those that apply):

☒ Early replacement of fully functioning equipment with new equipment. (Provide the date on which the customer replaced fully functioning equipment, and the date on which the customer would have replaced such equipment if it had not been replaced early. Please include a brief explanation for how the customer determined this future replacement date (or, if not known, please explain why this is not known)). **If Checked, Please see Exhibit 1 and Exhibit 2**

☐ Installation of new equipment to replace equipment that needed to be replaced The customer installed new equipment on the following date(s): _____.

☐ Installation of new equipment for new construction or facility expansion. The customer installed new equipment on the following date(s):

_____.

☐ Behavioral or operational improvement.

B) Energy savings achieved/to be achieved by the energy efficiency program:

1) If you checked the box indicating that the project involves the early replacement of fully functioning equipment replaced with new equipment, then calculate the annual savings [(kWh used by the original equipment) - (kWh used by new equipment) = (kWh per year saved)]. Please attach your calculations and record the results below:

   Annual savings: 2,108,554 kWh

2) If you checked the box indicating that the customer installed new equipment to replace equipment that needed to be replaced, then calculate the annual savings [(kWh used by less efficient new equipment) - (kWh used by the higher efficiency new equipment) = (kWh per year saved)]. Please attach your calculations and record the results below:

   Annual savings: _____ kWh

   Please describe any less efficient new equipment that was rejected in favor of the more efficient new equipment. **Please see Exhibit 1 if applicable**

3) If you checked the box indicating that the project involves equipment for new construction or facility expansion, then calculate the annual savings [(kWh used by less efficient new equipment) - (kWh used by higher efficiency new equipment) = (kWh per year saved)]. Please attach your calculations and record the results below:

   Annual savings: _____ kWh

   Please describe the less efficient new equipment that was rejected in favor of the more efficient new equipment. **Please see Exhibit 1 if applicable**

4) If you checked the box indicating that the project involves behavioral or operational improvements, provide a description of how the annual savings were determined.

Section 4: Demand Reduction/Demand Response Programs

A) The customer's program involves (check the one that applies):

☒ Coincident peak-demand savings from the customer's energy efficiency program.

☐ Actual peak-demand reduction. (Attach a description and documentation of the peak-demand reduction.)

☐ Potential peak-demand reduction (check the one that applies):

- ☐ The customer's peak-demand reduction program meets the requirements to be counted as a capacity resource under a tariff of a regional transmission organization (RTO) approved by the Federal Energy Regulatory Commission.

- ☐ The customer's peak-demand reduction program meets the requirements to be counted as a capacity resource under a program that is equivalent to an RTO program, which has been approved by the Public Utilities Commission of Ohio.

B) On what date did the customer initiate its demand reduction program?

Please reference Exhibit 2

C) What is the peak demand reduction achieved or capable of being achieved (show calculations through which this was determined):

Please reference Exhibit 2 kW

Section 5: Request for Cash Rebate Reasonable Arrangement (Option 1) or Exemption from Rider (Option 2)

Under this section, check the box that applies and fill in all blanks relating to that choice.

Note: If Option 2 is selected, the application will not qualify for the 60-day automatic approval. All applications, however, will be considered on a timely basis by the Commission.

A) The customer is applying for:

☒ Option 1: A cash rebate reasonable arrangement.

OR

☐ Option 2: An exemption from the energy efficiency cost recovery mechanism implemented by the electric utility.

OR

☐ Commitment payment

B) The value of the option that the customer is seeking is:

Option 1: A cash rebate reasonable arrangement, which is the lesser of (show both amounts):

☒ A cash rebate of $126,513. (Rebate shall not exceed 50% project cost. Attach documentation showing the methodology used to determine the cash rebate value and calculations showing how this payment amount was determined.)

Option 2: An exemption from payment of the electric utility's energy efficiency/peak demand reduction rider.

☐ An exemption from payment of the electric utility's energy efficiency/peak demand reduction rider for _____ months (not to exceed 24 months). (Attach calculations showing how this time period was determined.)

OR

☐ A commitment payment valued at no more than $_____. (Attach documentation and calculations showing how this payment amount was determined.)

OR

☐ Ongoing exemption from payment of the electric utility's energy efficiency/peak demand reduction rider for an initial period of 24 months because this program is part of the customer's ongoing efficiency program. (Attach documentation that establishes the ongoing nature of the program.) In order to continue the exemption beyond the initial 24 month period, the customer will need to provide a future application establishing additional energy savings and the continuance of the organization's energy efficiency program.)

Section 6: Cost Effectiveness

The program is cost effective because it has a benefit/cost ratio greater than 1 using the (choose which applies):

☐ Total Resource Cost (TRC) Test. The calculated TRC value is: _____(Continue to Subsection 1, then skip Subsection 2)

☒ Utility Cost Test (UCT) . The calculated UCT value is: **See Exhibit 3** (Skip to Subsection 2.)

Subsection 1: TRC Test Used (please fill in all blanks).

The TRC value of the program is calculated by dividing the value of our avoided supply costs (generation capacity, energy, and any transmission or distribution) by the sum of our program overhead and installation costs and any incremental measure costs paid by either the customer or the electric utility.

The electric utility's avoided supply costs were _______.

Our program costs were _______.

The incremental measure costs were _______.

Subsection 2: UCT Used (please fill in all blanks).

We calculated the UCT value of our program by dividing the value of our avoided supply costs (capacity and energy) by the costs to our electric utility (including administrative costs and incentives paid or rider exemption costs) to obtain our commitment.

Our avoided supply costs were **See Exhibit 3**

The utility's program costs were **See Exhibit 3**

The utility's incentive costs/rebate costs were **See Exhibit 3**

Section 7: Additional Information

Please attach the following supporting documentation to this application:

- Narrative description of the program including, but not limited to, make, model, and year of any installed and replaced equipment.
- A copy of the formal declaration or agreement that commits the program or measure to the electric utility, including:
  1) any confidentiality requirements associated with the agreement;
  2) a description of any consequences of noncompliance with the terms of the commitment;
  3) a description of coordination requirements between the customer and the electric utility with regard to peak demand reduction;
  4) permission by the customer to the electric utility and Commission staff and consultants to measure and verify energy savings and/or peak-demand reductions resulting from your program; and,
  5) a commitment by the customer to provide an annual report on your energy savings and electric utility peak-demand reductions achieved.
- A description of all methodologies, protocols, and practices used or proposed to be used in measuring and verifying program results. Additionally, identify and explain all deviations from any program measurement and verification guidelines that may be published by the Commission.

Ohio | **Public Utilities Commission**

Application to Commit Energy Efficiency/Peak Demand Reduction Programs (Mercantile Customers Only)

Case No.: 13 - 1540 **-EL-EEC**

State of Ohio :

, Affiant, being duly sworn according to law, deposes and says that:

1. I am the duly authorized representative of:

   Whirlpool Corporation
   [insert customer or EDU company name and any applicable name(s) doing business as]

2. I have personally examined all the information contained in the foregoing application, including any exhibits and attachments. Based upon my examination and inquiry of those persons immediately responsible for obtaining the information contained in the application, I believe that the information is true, accurate and complete.

Tim Ahlm, Controller
Signature of Affiant & Title

Sworn and subscribed before me this 12th day of June, 2013 Month/Year

Barbara Goshe
Signature of official administering oath

Print Name and Title

My commission expires on 4-17-2017

BARBARA A GOSHE
Notary Public, State of Ohio
My Commission Expires 4-17-2017

Exhibit 1

Customer Legal Entity Name: Whirlpool Corporation

Site Address: Whirlpool Corporation - Marion
Principal Address: 1300 Marion Agosta Rd.

Project No.	Project Name	Narrative description of your program including, but not limited to, make, model, and year of any installed and replaced equipment:	Description of methodologies, protocols and practices used in measuring and verifying project results	What date would you have replaced your equipment if you had not replaced it early? Also, please explain briefly how you determined this future replacement date.	Please describe the less efficient new equipment that you rejected in favor of the more efficient new equipment.
1	Compressed Air System Upgrade	Two 900-hp centrifugal air compressors replaced four rotary screw air compressors. These air compressors have a higher specific efficiency than the replaced units. Furthermore, the old compressors had to be staged on manually, resulting in excessive capacity being online for a significant amount of time. The new compressors have controls to automatically stage them to follow compressed air demand, further reducing energy consumption. The new compressors were installed in January of 2013. Please refer to the "Whirlpool Marion First Energy Rebate Analsysis.pdf" included with this application for a detailed description and analysis of old and new compressed air systems.	Fundamental air compressor relationships were used to estimate the energy savings from installing the new centrifugal air compressors. Please refer to the "Whirlpool Marion First Energy Rebate Analsysis.pdf" included with this application for a detailed description and analysis of old and new compressed air systems.	The plan to replace the equipment was 2015 based on budget and production timing and cost of future energy cost.	N/A
2	Wet-Paint Chilled Water System Upgrade	One 300 ton variable speed centrifugal replaced an air cooled screw chiller and a backup 99 ton reciprocating water cooled chiller. The new chiller has a higher specific efficiency than the replaced units. A new cooling tower with a variable speed fan serves the condenser side of the new chiller. On-board controls reset the condenser water temperature setpoint based on outdoor air conditions and chiller loading, optimizing total system energy consumption. The new chiller and cooling tower were installed in 2012. Please refer to the "Whirlpool Marion First Energy Rebate Analsysis.pdf" included with this application for a detailed description and analysis of the old and new Wet-paint chilled water system.	Fundamental chiller relationships were used to estimate the energy savings from installing the new variable speed centrifugal chiller. Please refer to the "Whirlpool Marion First Energy Rebate Analsysis.pdf" included with this application for a detailed description and analysis of old and new chilled water systems.	The plan to replace the equipment was 2017 based on budget and production timing and cost of future energy cost.	N/A

Docket No. 13-1540
Site: 1300 Marion Agosta Rd.

Exhibit 2

Customer Legal Entity Name: Whirlpool Corporation
Site Address: Whirlpool Corporation - Marion
Principal Address: 1300 Marion Agosta Rd.

	Unadjusted Usage, kwh (A)	Weather Adjusted Usage, kwh (B)	Weather Adjusted Usage with Energy Efficiency Addbacks, kwh (c) *Note 1*
2012	54,872,064	54,872,064	55,136,045
Average	**54,872,064**	**54,872,064**	**55,136,045**

Project Number	Project Name	In-Service Date	Project Cost $	50% of Project Cost $	KWh Saved/Year (D) counting towards utility compliance	KWh Saved/Year (E) eligible for incentive	Utility Peak Demand Reduction Contribution, KW (F)	Prescriptive Rebate Amount (G) $	Eligible Rebate Amount (H) $ *Note 2*	Commitment Payment $
1	Compressed Air System Upgrade	01/01/2013	$827,254	$413,627	1,792,812	1,792,812	561	$143,425	$107,569	
2	Wet-Paint Chilled Water System Upgrade	03/01/2012	$403,057	$201,529	315,742	315,742	57	$25,259	$18,944	
					-	-	-			
					-	-	-			
					-	-	-			
					-	-	-			
					-	-	-			
		Total	$1,230,311		2,108,554	2,108,554	618	$168,684	$126,513	$0

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Notes
(1) Customer's usage is adjusted to account for the effects of the energy efficiency programs included in this application. When applicable, such adjustments are prorated to the in-service date to account for partial year savings.

(2) The eligible rebate amount is based upon 75% of the rebates offered by the FirstEnergy Commercial and Industrial Energy Efficiency programs or 75% of $0.08/kWh for custom programs for all energy savings eligible for a cash rebate as defined in the PUCO order in Case NO.10-834-EL-EEC dated 9/15/2010, not to exceed the lesser of 50% of the project cost or $250,000 per project. The rebate also cannot exceed $500,000 per customer per year, per utility service territory.

Exhibit 3 Utility Cost Test

UCT = Utility Avoided Costs / Utility Costs

Project	Total Annual Savings, MWh (A)	Utility Avoided Cost $/MWh (B)	Utility Avoided Cost $ (C)	Utility Cost $ (D)	Cash Rebate $ (E)	Administrator Variable Fee $ (F)	Total Utility Cost $ (G)	UCT (H)
1	1,793	$ 308	$ 552,688	$ 2,025	$107,569	$17,928	$ 127,522	**4.3**
2	316	$ 308	$ 97,337	$ 2,025	$18,944	$3,157	$ 24,127	**4.03**
Total	**2,109**	**$ 308**	**650,025**	**4,050**	**$126,513**	**$21,086**	**151,649**	**4.3**

Notes

(A) From Exhibit 2, = kWh saved / 1000

(B) This value represents avoided energy costs (wholesale energy prices) from the Department of Energy, Energy Information Administration's 2009 Annual Energy Outlook (AEO) low oil prices case. The AEO represents a national average energy price, so for a better representation of the energy price that Ohio customers would see, a Cinergy Hub equivalent price was derived by applying a ratio based on three years of historic national average and Cinergy Hub prices.This value is consistent with avoided cost assumptions used in EE&PDR Program Portfolio and Initial Benchmark Report, filed Dec 15, 2009 (See Section 8.1, paragraph a).

(C) = (A) * (B)

(D) Represents the utility's costs incurred for self-directed mercantile applications for applications filed and applications in progress. Includes incremental costs of legal fees, fixed administrative expenses, etc.

(E) This is the amount of the cash rebate paid to the customer for this project.

(F) Based on approximate Administrator's variable compensation for purposes of calculating the UCT, actual compensation may be less.

(G) = (D) + (E) + (F)

(H) =(C) / (G)

Whirlpool Corporation ~ Whirlpool Corporation - Marion
Docket No. 13-1540

Site: 1300 Marion Agosta Rd.

Whirlpool Marion Energy Reduction Narrative

The compressed air and the Wet-Paint chilled water systems serving industrial process loads at the Marion, Ohio Whirlpool plant have been recently upgraded with high efficiency equipment. Both upgrades have resulted in significant energy and peak demand reductions.

The compressed air system serving process loads at the Marion, Ohio Whirlpool plant was upgraded in early 2013 to a higher efficiency compressed air system. This included installing two new centrifugal compressors to carry the primary plant air load and removal of four old rotary screw compressors. Prior to 2013 the plant operated with the configuration of seven rotary screw air compressors, shown in Table 1.

Compressor ID	Model	Make	Motor Rating (hp)
Compressor #1	MN 32-450H	Sullair	500
Compressor #2	MN 32-450H	Sullair	450
Compressor #3	MN 32-450H	Sullair	450
Compressor #4	MN 32-450H	Sullair	450
Compressor #5	LS-25-200 L WC	Sullair	200
Compressor #6	LS-25-200 H WC	Sullair	200
Compressor #7	SSR-EPE 450-2S	Ingersoll Rand	450

Table 1: Pre-2013 Compressor System Inventory

The post-2013 plant compressed air system operates with two new centrifugal and the three old rotary screw air compressors shown in Table 2.

Compressor ID	Model	Make	Motor Rating (hp)
Centrifugal 1	C700	Ingersoll Rand	900
Centrifugal 2	C700	Ingersoll Rand	900
Compressor #5	LS-25-200 L WC	Sullair	200
Compressor #6	LS-25-200 H WC	Sullair	200
Compressor #7	SSR-EPE 450-2S	Ingersoll Rand	450

Table 2: Post-2013 Compressor System Inventory

The chilled water system serving process loads at the Marion, Ohio Whirlpool plant was upgraded in 2012 to a highly energy efficient chilled water system. This included replacing an air cooled screw chiller and air cooled reciprocating chillers with a variable speed centrifugal water cooled chiller. Additionally, a new cooling tower with a variable speed fan with advanced controls was also installed.

1.1.1 Baseline System Equipment Discussion

The Baseline chilled water system consisted of a 177-ton air cooled screw chiller and two 99-ton air cooled reciprocating chillers. The screw chiller was staged as the lead chiller with a chilled water supply (CWS) set-point of 44°F. The reciprocating chillers were maintained in standby mode in case operation of the lead chiller was interrupted. Table 3 lists the general chiller information.

	Lead Screw Chiller	Trim Recip. Chiller	Trim Recip. Chiller
Man.	Carrier	Carrier	Carrier
Mo.	30HXA186RY	30HS100-A160	30HS100-A160
SN.	1909Q17524	B984097	-
Capacity Ref.	177 ton	99 ton	99 ton
Input Power Ref.	192 kW	92 kW	92 kW

Table 3: Baseline Chiller Nameplate Data

Each chiller was equipped with an outdoor mounted air cooled refrigerant condenser. Each condenser was equipped with several fans to cool the refrigerant with ambient air. These fans were staged on with the chiller compressors. Chilled water was provided to a chilled water tank located near the process loads.

The new chilled water system consists of a 300 ton water cooled centrifugal chiller and the old 177 ton air cooled screw chiller. The water cooled chiller is staged as the lead chiller with a chilled water supply (CWS) set-point of 44°F. The air cooled chiller serves as a backup with a CWS set-point of 53 F. The backup chiller is maintained in standby mode in case operation of the lead chiller is interrupted. Table 3 lists the general chiller information.

	Lead Centrifugal Chiller	Backup Screw Chiller
Man.	Trane	Carrier
Mo.	CVHE045	30HXA186RY
SN.	N4F767A	1909Q17524
Capacity Ref.	300 ton	177 ton
Input Power Ref.	158 kW	192 kW

Table 4: Chiller Nameplate Data

The lead chiller rejects heat to the atmosphere through a 400 nominal ton induced draft closed circuit (EVAPCO ESWA-216-45L) cooling tower. The cooling tower has a 25-hp variable speed fan controlled by the chiller's onboard control board. These controls vary the condenser water temperature set-point based on ambient conditions and chiller loading. The backup chiller rejects heat to the ambient through an air cooled refrigerant condenser. Chilled water is provided to a chilled water tank located near the process loads.

Whirlpool Marion M&V Methods

The energy savings for the upgrades of the compressed air and the Wet-Paint chilled water systems were calculated using a combination of IPMV options B (Retrofit Isolation) and D (Calibrated Simulation). This combination was necessary because direct measurement of the old and new systems was not possible. Direct measurement of both old and new systems was not possible since the upgrades were already completed or in the process of completion. The methods and equipment performance parameters used is described in detail in the included energy study “Whirlpool Marion First Energy Rebate Analsysis.pdf”

Ohio Edison • The Illuminating Company • Toledo Edison

Mercantile Customer Program - Custom Project Rebate Calculator

Project Name and Number:	Compressed air & chiller system upgrade
Site Name:	**Whirlpool Corporation - Marion**
Completed by (Name):	**David Freyhof**
Date completed:	**6/12/2013**

Energy Conservation Measure	Annual Energy Savings kWh	Eligible Prescriptive Rebate Amount kWh * $0.08
Compressed Air System Upgrade	**1,792,812**	**143424.96**
Wet-Paint Chilled Water System Upgrade	**315,742**	**25259.36**
Total Project Energy Savings kWh	**2,108,554**	
Total Custom Prescriptive Rebate Amount $		**$ 168,684.32**

Notes about this rebate calculation:
Please refer to the attached document for a detailed description and energy savings calculations for the above projects: "Whirlpool Marion First Energy Rebate Analsysis.pdf"

Energy Efficiency Rebate Report

for

Whirlpool

By

go sustainable energy

April 2013

Table of Contents

1 Executive Summary

The compressed air and the Wet-Paint chilled water systems serving industrial process loads at the Marion, Ohio Whirlpool plant have been recently upgraded with high efficiency equipment. Both upgrades have resulted in significant energy and peak demand reductions, which are summarized in Table 1.

		Energy (kWh/yr)	Peak Demand (kW)	Energy Cost ($/yr)	Demand Cost ($/yr)	Total Cost ($/yr)
Air Compressor System	Baseline - Pre-2013	9,979,524	2,019	$501,970	$47,233	$549,203
	New - Post-2013	8,186,712	1,458	$411,792	$34,114	$445,906
	Savings	**1,792,812**	**561**	**$90,178**	**$13,119**	**$103,297**
Chilled Water System	Baseline	671,714	155	$33,787	$3,093	$36,881
	New	355,972	98	$17,905	$1,859	$19,765
	Savings	**315,742**	**57**	**$15,882**	**$1,234**	**$17,116**
Total Savings		**2,108,554**	**618**	**$106,060**	**$14,353**	**$120,413**

Table 1: Project Savings Summary

This energy savings analysis is submitted with the included First Energy Mercantile Customer Program application. The cash rebate option is being pursued and The Ohio Manufacturers' Association is the administrator for this application.

2 Utility Analysis

2.1 Rate Schedule and Avoided Costs

The latest available electricity bill was evaluated to determine how the Marion Whirlpool plant is charged for electricity. The plant purchases its electric generation from First Energy Solutions Corporation and uses Ohio Edison utility lines for distribution. Whirlpool is billed under the Ohio Edison General Service Sub-transmission (OE-GSUD) tariff. We used the distribution charges and riders from this rate in addition to the First Energy Solutions generation charge to find the electricity rate schedule. Table 2 presents summarized information for this rate structure in terms of service, energy, peak demand and power factor.

Simplified Rate Schedule		
Service	$210.31	/ month
Energy	$0.0534	/kWh for first 2000 kWh
	$0.0534	/kWh for 2,001 to 15,000 kWh
	$0.0534	/kWh for 15,001 to 833,000 kWh
	$0.0503	/kWh for all kWh above 833,000 kWh
Demand	$1.95	/kW for all kW

*PF of 0.98 assumed

Table 2: Simplified Rate Structure

We use the avoided costs, shown in Table 3, throughout this report to convert energy savings into cost savings.

Energy Component	Avoided Cost
Electrical Energy ($/kWh)	$0.0503
Electrical Demand ($/kW)	$1.95

Table 3: Avoided Costs

2.2 Transformer Energy Consumption Adjustment

The plant is served by the utility's electrical lines at a sub-transmission level of 34,500 volts. The voltage is then reduced by a transformer to 4,160 volts and distributed to several substations throughout the plant. Certain equipment such as the air compressors are powered directly from the 4,160 volt substations. However, the majority of the plant equipment, including the chillers, operates at 480 volts. Another transformer is required to provide 480 volts to this equipment.

Electrical transformers are about 98% efficient when stepping down voltage. The utility meter is located prior to these Whirlpool owned transformers. Thus the energy losses of the transformers must be accounted for to properly calculate the energy savings realized at the meter. The energy and demand savings calculated for the air compressor and chiller upgrades are adjusted to account for the appropriate transformers. Thus, demand reductions and energy savings associated with the air compressors will be increased by a factor of 1.02 and 1.04 for the chilled water system upgrades.

3 Compressed Air System Analysis

The compressed air system serving process loads at the Marion, Ohio Whirlpool plant was recently upgraded to a higher efficiency compressed air system. This included installing two new centrifugal compressors to carry the primary plant air load and removal of four old rotary screw compressors. This project has increased the energy efficiency and reliability of the compressed air system.

The following sections describe the equipment, operation and performance of the compressed air system before and after the upgrade. A compressed air flow profile is developed from logged power data. The algorithms used to simulate energy consumption of the new compressed air system are detailed. Finally, energy and cost savings realized from upgrading the system are presented. This analysis is provided in support of the accompanying First Energy Rebate application.

3.1 Pre-2013 and Post-2013 System Information

The following sections describe the equipment, operation and performance of the compressed air system before and after the upgrade. A general description of the Pre-2013 and Post-2013 systems is provided. Equipment specifications and staging sequences are provided in this section.

3.1.1 Pre-2013 Air System Equipment and Controls

Prior to 2013, and during our first site visit, the plant operated with the configuration of seven rotary screw air compressors, shown in Table 4.

Compressor ID	Model	Make	Motor Rating (hp)
Compressor #1	MN 32-450H	Sullair	500
Compressor #2	MN 32-450H	Sullair	450
Compressor #3	MN 32-450H	Sullair	450
Compressor #4	MN 32-450H	Sullair	450
Compressor #5	LS-25-200 L WC	Sullair	200
Compressor #6	LS-25-200 H WC	Sullair	200
Compressor #7	SSR-EPE 450-2S	Ingersoll Rand	450

Table 4: Pre-2013 Compressor System Inventory

Based on our logged data these compressors all operated in modulation mode and never appeared to blow-down/unload. Based on our logged data and conversations with facility management, we believe the compressors were only controlled manually and forced on and off as it was believed they were needed.

3.1.2 Post-2013 Air System Equipment and Controls

The post-2013 plant compressed air system operates with two new centrifugal and the three old rotary screw air compressors shown in Table 5.

Compressor ID	Model	Make	Motor Rating (hp)
Centrifugal 1	C700	Ingersoll Rand	900
Centrifugal 2	C700	Ingersoll Rand	900
Compressor #5	LS-25-200 L WC	Sullair	200
Compressor #6	LS-25-200 H WC	Sullair	200
Compressor #7	SSR-EPE 450-2S	Ingersoll Rand	450

Table 5: Post-2013 Compressor System Inventory

The new centrifugal compressors have internal sequencing controls capable of controlling several similar units. These controls minimize energy consumption reducing the amount of time either centrifugal compressor spends bypassing. A general sequence of operation for the weekday operation is shown below. This sequence of operation is meant as a general guide of how the centrifugal air compressors operate.

Weekday Sequence of Operation

- *After stable operation has been achieved following manufacturer's startup procedures the compressors shall operate in a lead and lag configuration.*
- *Both lead and lag compressors shall modulate inlet guide vanes (IGV) to minimum position (closed) and bypass dampers fully closed.*
- *Upon compressed air demand exceeding output, lead compressor shall incrementally modulate IGVs open to meet demand. Lag compressor IGVs shall remain in minimum position until lead compressor IGVs are fully open.*
    - *When compressed air demand exceeds output with lead IGVs fully open lag compressor IGVs shall incrementally modulate open to meet demand.*
- *Upon decrease in compressed air demand lag compressor IGVs shall incrementally modulate closed to decrease output to meet demand. Lead compressor IGVs shall remain fully open until lag compressor IGVs are at minimum position.*
    - *When demand is less than output of system with lead IGVs fully open and lag IGVs at minimum, the lead IGVs shall incrementally modulate to closed position decreasing output to meet demand.*
    - *When demand is less than output of system with lead and lag IGVs at minimum position, lag compressor shall incrementally open the bypass damper to decrease output to meet demand.*
    - *When demand is less than output of system with lead IGVs at minimum position and the lag compressor bypass damper fully open the, the lead compressor shall incrementally open bypass damper to decrease output to meet demand.*

The two 200-hp Sullair compressors are manually turned on if necessary, but are typically off. The 450-hp Ingersoll Rand screw compressor is for backup and is typically not used. A photo of one of the 900-hp centrifugal compressors, during installation, is shown in Figure 1. According to plant management, only one of the 900-hp centrifugal compressors is needed during weekends along with one or two of the 200-hp Sullair compressors, occasionally.

Figure 1: New 900-hp Centrifugal Compressor Being Installed

3.2 Logged Data and Pre-2013 Energy Consumption

We logged the seven pre-2013 air compressors for five days. One phase of each air compressor was logged at its associated 4,160 volt power cabinet. The five days included three weekdays and two weekend days. In addition, compressed air line pressure in the plant was logged for ten days. Based on the pressure data, the compressed air system maintains an average air pressure of about 95 psig. All logged data is shown in Appendix A. Figure 2 shows the logged electrical current data for all seven pre-2013 air compressors.

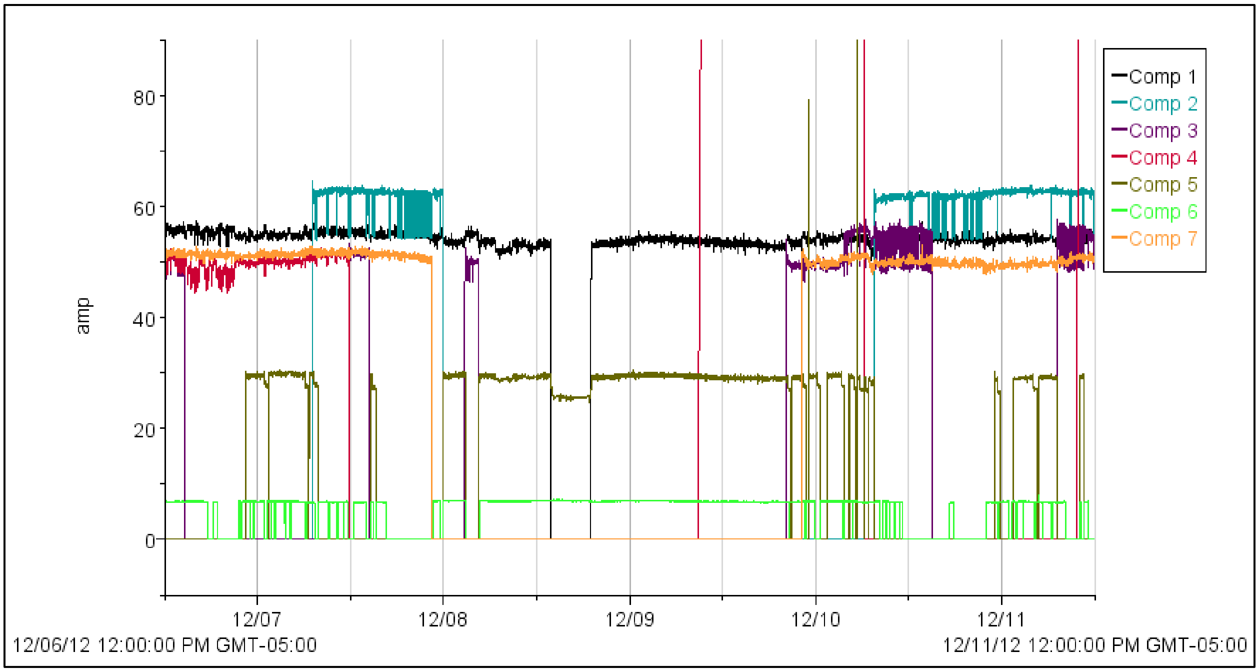

Figure 2: Logged Pre-2013 Compressor System Data

It should be noted that the logged amperage draws for compressor 4 and 6 were corrected for un-reliable data. The methods used are discussed in detail in Appendix A of this report.

3.2.1 Pre-2013 Energy Consumption and Peak Demand

Power draw of each air compressor was calculated for each interval of the logged amperage data. The following formula was used to calculate the power draw:

$$Power\ draw\ (kW) = \frac{Amperage\ (A) \times Voltage\ (V) \times \sqrt{3} \times Power\ factor\ \left(\frac{kW}{kVA}\right)}{1{,}000\ \left({}^{VA}/_{kVA}\right)}$$

We assume the voltage is equal to the nominal plant voltage and the power factor (PF) is a linear function based on percent of maximum amperage and the maximum and minimum loaded PF's shown in Table 6.

Compressor ID	Motor Rating (hp)	CAGI Loaded Power (kW)	Nominal Voltage (V)	CAGI Rated Pressure (psig)	CAGI Rated Flow (acfm)	Cmax: Estimated Flow @ 100 psig (acfm)	Estimated Max Loaded PF (kW/kVA)	Estimated Min Loaded PF (kW/kVA)
Compressor #1	500	368.3	4,160	125	2,135	2,316	0.85	0.64
Compressor #2	450	368.3	4,160	125	2,135	2,316	0.85	0.64
Compressor #3	450	368.3	4,160	125	2,135	2,316	0.85	0.64
Compressor #4	450	368.3	4,160	125	2,135	2,316	0.85	0.64
Compressor #5	200	177.8	4,160	100	980	980	0.85	0.64
Compressor #6	200	177.2	4,160	125	897	973	0.85	0.64
Compressor #7	450	386.1	4,160	125	2,245	2,436	0.85	0.64

Table 6: Pre-2013 Compressor Performance Ratings

Analyzing the amperage data we determined the percent runtimes for the air compressors during the period we metered. The average amperage and power draw were calculated from the logged data. The weekend period was weighted by a factor of 2/7 and the weekday data was weighted by a factor of 5/7 to account for the partial week logging period. The annual energy use for each compressor was calculated using the average power draw and an annual operation of 8,760 hours. The compressed air system operates continuously even during shut-down periods according to plant management. The total peak demand and energy consumption of the compressors was increased by a factor of 1.02 to determine the energy use at the utility meter. This is done to account for the 34,500 volt to 4,160 volt set-down transformer after the utility meter. This approach is discussed in detail in the Utility Analysis section of this report. Table 7 summarizes the measured amperage, the calculated percent runtime, calculated power draw, and the calculated annual energy use.

Compressor	Comp. #1	Comp. #2	Comp. #3	Comp. #4	Comp. #5	Comp. #6	Comp. #7	Total
Fraction Time Active (%)	96.9%	45.0%	28.6%	41.3%	49.7%	68.7%	71.0%	
Avg. Total Amperage (A)	52.7	27.7	15.0	57.7	14.4	4.7	35.9	
Avg. Total Power Draw (kW)	323.3	170.2	91.0	126.2	88.1	120.2	220.3	
Annual Energy Use (kWh/yr)	2,831,793	1,491,321	796,918	1,105,286	771,394	1,053,339	1,929,472	**9,979,524**

Table 7: Summary of Amperage Data and the Calculated Power Draw and Energy Use

Billed demand is based on the greatest on-peak electricity consumption over any 30-minute period. In order to determine the peak demand, we calculated the combined average rolling 30-minute power draw for the pre-2013 compressed air system. Figure 3 shows the compressed air system's electricity demand over time in the logged period. Based on this information, we determined the greatest 30-minute average power draw to be 2,019 kW.

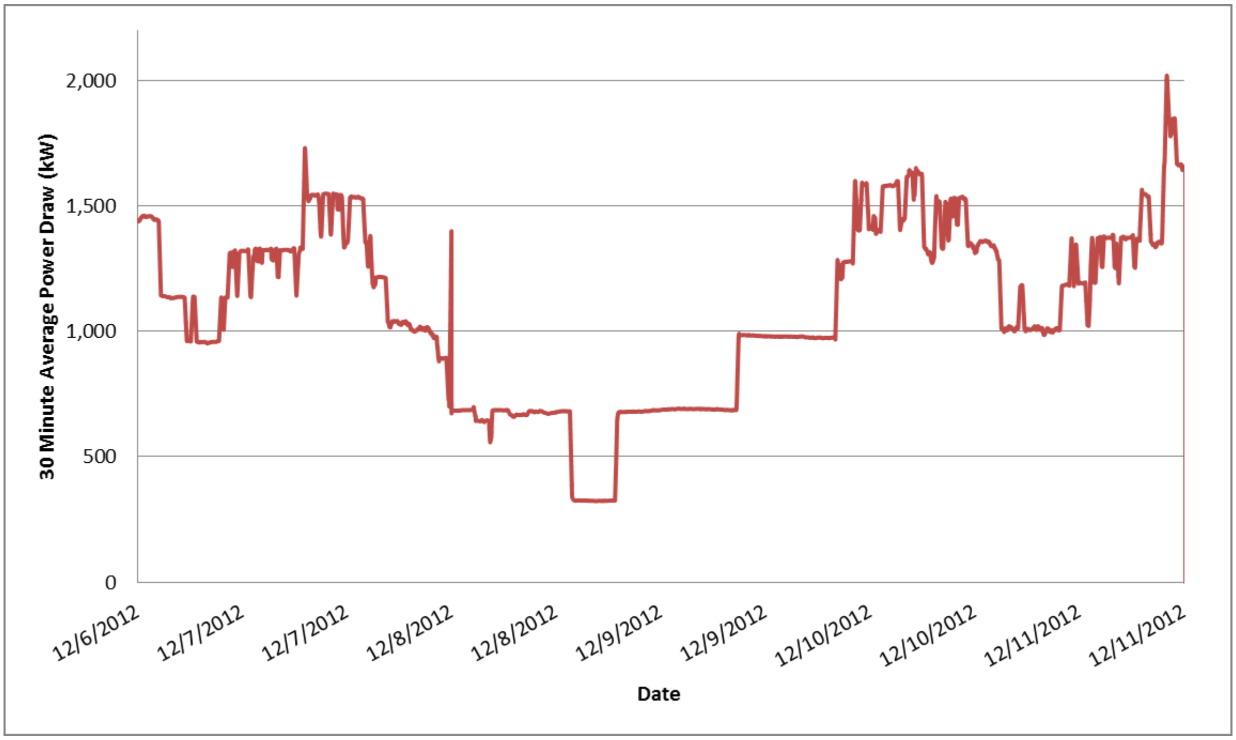

Figure 3: Pre-2013 Rolling 30-Minute Average Demand

Table 8 shows a summary of the Pre-2013 compressed air system annual energy consumption, peak demand and costs. The costs were calculated using the avoided cost of energy and demand presented in the Utility Analysis section.

Total Compressor System Energy Cost and Usage	
Annual Energy	9,979,524
Monthly Demand	2,019
Energy Cost	$501,970
Demand Cost	$47,233
Total Cost	$549,203

Table 8: Summary of Pre-2013 System Energy and Cost

3.3 Compressed Air Consumption Profile

The logged compressor data is used to derive a compressed air load profile. Production during our site visit was typical of normal production, according to plant management. Thus, we assume this load profile is representative of the compressed air consumption throughout the year. Compressed air output of a compressor is estimated from the power draw.

The fraction compressed air capacity (FC) is related to the fraction of full load power (FP) draw by the following equation, where FP_0 is the fraction power at zero capacity:

$$FP = FP_0 + (1 - FP_0) \times FC$$

This equation is shown graphically in Figure 4 as a set of curves corresponding to different capacity control modes.

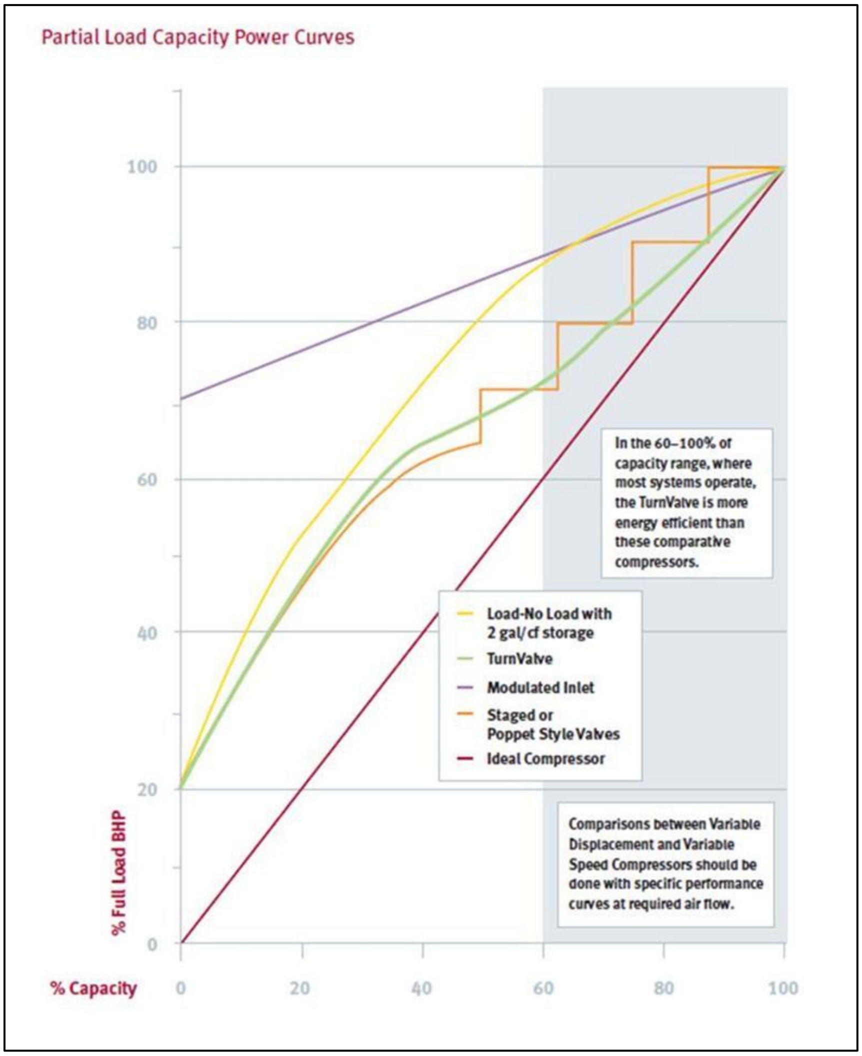

Figure 4: Typical Fraction Power vs. Fraction Capacity Curves

Figure 5 shows a performance curve for a generic centrifugal air compressor with inlet guide vane modulation. This curve was taken from the Department of Energy's compressed air simulation program AirMaster.

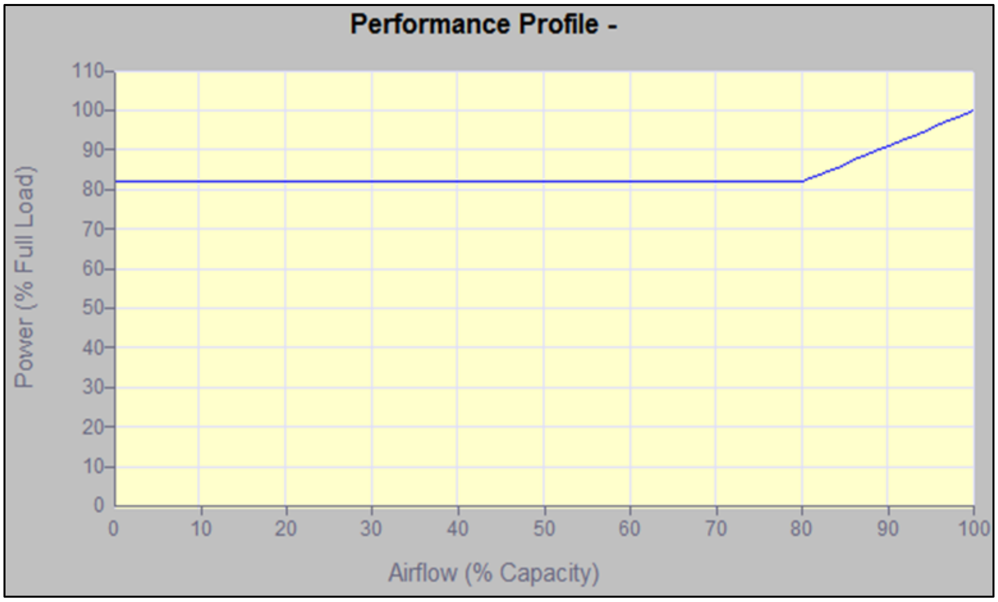

Figure 5: Centrifugal Air Compressor Performance Curve

The air compressors in the pre-2013 system were operating in modulation control mode. This is represented in Figure 4 as the "modulated inlet" curve. It is evident that compressors operating in modulation control draw about 70% of full load power when completely unloaded. Thus, the following equation can be used to describe the operation of the pre-2013 air compressors.

$FP = 0.7 + (1 - 0.7) \times FC$

The FP of the air compressors was calculated from the calculated power divided by the max power draw listed in Table 6 for each interval of logged data. With the FP of the compressor known, the FC and the compressed air flowrate of the air compressors can be estimated using the following equation:

$FC = (FP - 0.7) / 0.3$

$Cflowrate = Cmax \times FC$

Where *Cmax* is the full load compressed air flowrate listed in Table 6. The flowrate for each compressor was calculated and totaled for each interval of logged data. Figure 6 shows a graph of the compressed air load profile. The weekdays are shown in blue and weekend days are shown in green.

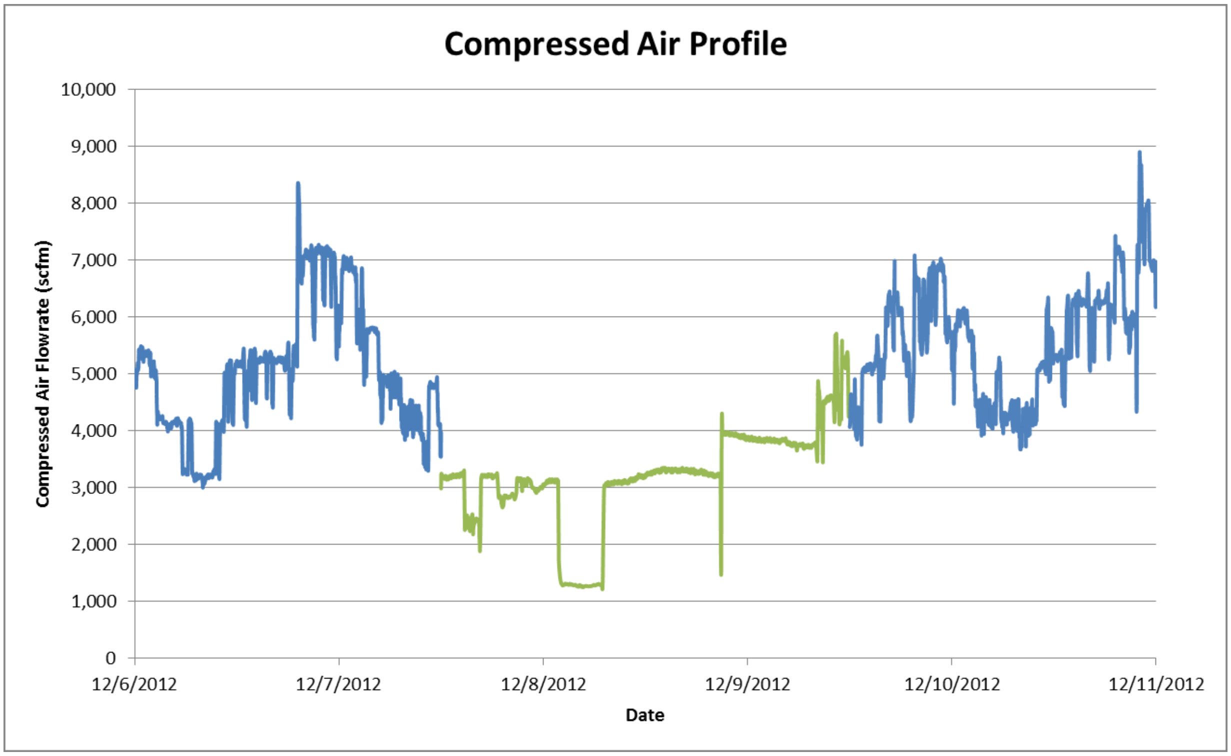

Figure 6: Compressed Air Profile

This profile is used to calculate the energy consumption of the post-2013 compressed air system.

3.4 Post-2013 Compressed Air System Energy Consumption

Power consumption is calculated by determining the number of compressors required and their associated FC given the compressed air load. With the FC known, the FP for each active air compressor can be calculated using the following equation, where FP_0 is the fraction power at zero capacity:

$$FP = FP_0 + (1 - FP_0) \times FC$$

Figure 7 shows the performance curve from the equipment selection provided to Whirlpool by Ingersoll Rand.

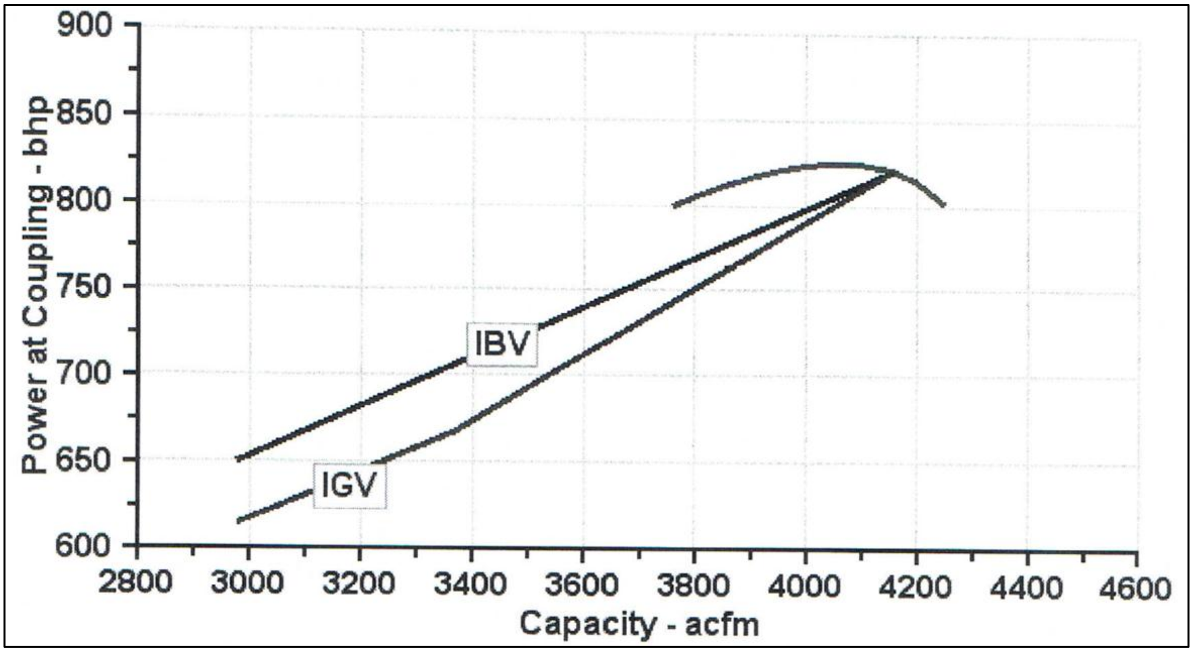

Figure 7: IR Centrifugal Performance Curve

The FP_0 of the centrifugal compressors is estimated to be about 0.72 at a FC of 0.72 from Figure 7. Thus, the FP is calculated using the following equations for the centrifugal compressors and modulating screw compressors respectively:

Centrifugal: $FP = 0.72 + (1 - 0.72) \times FC$

Modulating Screw: $FP = 0.7 + (1 - 0.7) \times FC$

The power draw of each active compressor is then calculated using the loaded power draw *(Pmax)* listed in Table 9 and the following equation:

$P = Pmax \times FP$

Compressor ID	Motor Rating (hp)	Pmax: CAGI Loaded Power (kW)	Nominal Voltage (V)	CAGI Rated Pressure (psig)	CAGI Rated Flow (acfm)	Cmax: Estimated Flow @ 100 psig (acfm)	Estimated Loaded PF (kW/kVA)	Estimated Un-loaded PF (kW/kVA)
Centrifugal 1	900	700.0	4,160	115	4,157	4,323	0.88	0.66
Centrifugal 2	900	700.0	4,160	115	4,157	4,323	0.88	0.66
Compressor #5	200	177.8	4,160	100	980	980	0.85	0.64
Compressor #6	200	177.2	4,160	125	897	973	0.85	0.64
Compressor #7	450	386.1	4,160	125	2,245	2,436	0.85	0.64

Table 9: Post-2013 Compressor Performance Ratings

The power draw for each compressor was totaled and averaged over 30 minutes to determine the peak demand. The energy consumption of the post-2013 system was estimated from the calculated power draw and extrapolating to account for the annual operating hours of 8,760. The total peak demand and energy consumption of the compressors was increased by a factor of 1.02 to determine the energy use at the utility meter. This is done to account for the 34,500 volt to 4,160 volt set-down transformer after the utility meter. This approach is discussed in detail in the Utility Analysis section of this report. A summary of annual compressed air energy consumption and costs is shown in Table 10.

Total Compressor System Energy Cost and Usag	
Annual Energy	8,186,712
Monthly Demand	1,458
Energy Cost	$411,792
Demand Cost	$34,114
Total Cost	$445,906

Table 10: Energy Consumption and Cost Summary

3.5 Energy and Cost Savings Summary

The energy, peak demand and cost savings are taken as the difference between the Pre-2013 and Post-2013 systems. Table 11 shows a summary of the energy, peak demand and cost savings from upgrading the compressed air system.

Total Energy Cost and Usage Savings			
	Baseline - Pre-2013	**New - Post-2013**	**Savings**
Annual Energy	9,979,524	8,186,712	**1,792,812**
Monthly Demand	2,019	1,458	**561**
Energy Cost	$501,970	$411,792	**$90,178**
Demand Cost	$47,233	$34,114	**$13,119**
Total Cost	$549,203	$445,906	**$103,297**

Table 11: Project Savings Summary

4 Wet Paint Chilled Water System Upgrade Analysis

A chilled water system serving process loads at the Marion, Ohio Whirlpool plant was recently upgraded to a highly energy efficient chilled water system. This included replacing an air cooled screw chiller and air cooled reciprocating chillers with a variable speed centrifugal water cooled chiller. Additionally, a new cooling tower with a variable speed fan with advanced controls was also installed. This project has increased the energy efficiency and reliability of the chilled water system.

The following sections describe the equipment, operation and performance of the chilled water systems before and after the upgrade. Next, a cooling load profile is developed from logged power data. The algorithm used to simulate the energy consumption of the chilled water systems is detailed. Finally, energy and cost savings realized from upgrading the system are presented. This analysis is provided in support of the accompanying First Energy Rebate application.

4.1 Baseline and New System Information

The following sections describe the equipment, operation and performance of the chilled water system before and after the upgrade. First, a general description of the Baseline and New systems is provided. Equipment specifications and control setpoints are provided in this section. Next, detailed performance models for the chillers and cooling towers is presented.

4.1.1 Baseline System Equipment Discussion

The Baseline chilled water system consisted of a 177-ton air cooled screw chiller and two 99-ton air cooled reciprocating chillers. The screw chiller was staged as the lead chiller with a chilled water supply (CWS) set-point of 44°F. The reciprocating chillers were maintained in standby mode in case operation of the lead chiller was interrupted. Table 12 lists the general chiller information.

	Lead Screw Chiller	Trim Recip. Chiller	Trim Recip. Chiller
Man.	Carrier	Carrier	Carrier
Mo.	30HXA186RY	30HS100-A160	30HS100-A160
SN.	1909Q17524	B984097	-
Capacity Ref.	177 ton	99 ton	99 ton
Input Power Ref.	192 kW	92 kW	92 kW

Table 12: Baseline Chiller Nameplate Data

Each chiller was equipped with an outdoor mounted air cooled refrigerant condenser. Each condenser was equipped with several fans to cool the refrigerant with ambient air. These fans were staged on with the chiller compressors. Chilled water was provided to a chilled water tank located near the process loads. Three 10-hp pumps serve four heat exchangers that cool Dip tanks 1 through 3. The pumps extract water from the bottom of the tank and return water to the top of the tank. A 2-hp pump circulates water in the tank to maintain an even temperature in the tank. Figure 8 shows a schematic diagram of the Baseline chilled water systems.

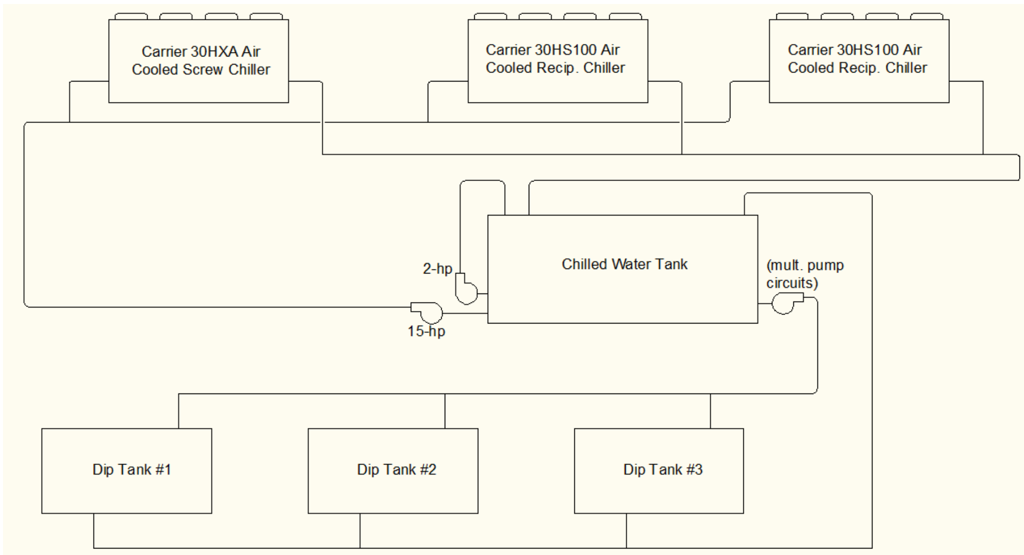

Figure 8: Baseline - Wet Paint Chilled Water System Diagram

4.1.2 New System Equipment Discussion

The new chilled water system consists of a 300 ton water cooled centrifugal chiller and the old 177 ton air cooled screw chiller. The water cooled chiller is staged as the lead chiller with a chilled water supply (CWS) set-point of 44°F. The air cooled chiller serves as a backup with a CWS set-point of 53 F. The backup chiller is maintained in standby mode in case operation of the lead chiller is interrupted. The old reciprocating chillers are no longer regularly utilized in the Wet Paint Chilled water system. However, they have been left in place to act as additional backups to the backup 177 ton air cooled screw chiller. Table 12 lists the general chiller information.

	Lead Centrifugal Chiller	Backup Screw Chiller
Man.	Trane	Carrier
Mo.	CVHE045	30HXA186RY
SN.	N4F767A	1909Q17524
Capacity Ref.	300 ton	177 ton
Input Power Ref.	158 kW	192 kW

Table 13: Chiller Nameplate Data

The lead chiller rejects heat to the atmosphere through a 400 nominal ton induced draft closed circuit (EVAPCO ESWA-216-45L) cooling tower. The cooling tower has a 25-hp variable speed fan controlled by the chiller's onboard control board. These controls vary the condenser water temperature set-point based on ambient conditions and chiller loading. The backup chiller rejects heat to the ambient through an air cooled refrigerant condenser. Chilled water is provided to a chilled water tank located near the process loads. Three 10-hp pumps serve four heat exchangers that cool Dip tanks 1 through 3. The pumps extract water from the bottom of the tank and return water to the top of the tank. A 2-hp pump circulates water in the tank to maintain an even temperature in the tank. Figure 8 shows a schematic diagram of the chilled water systems.

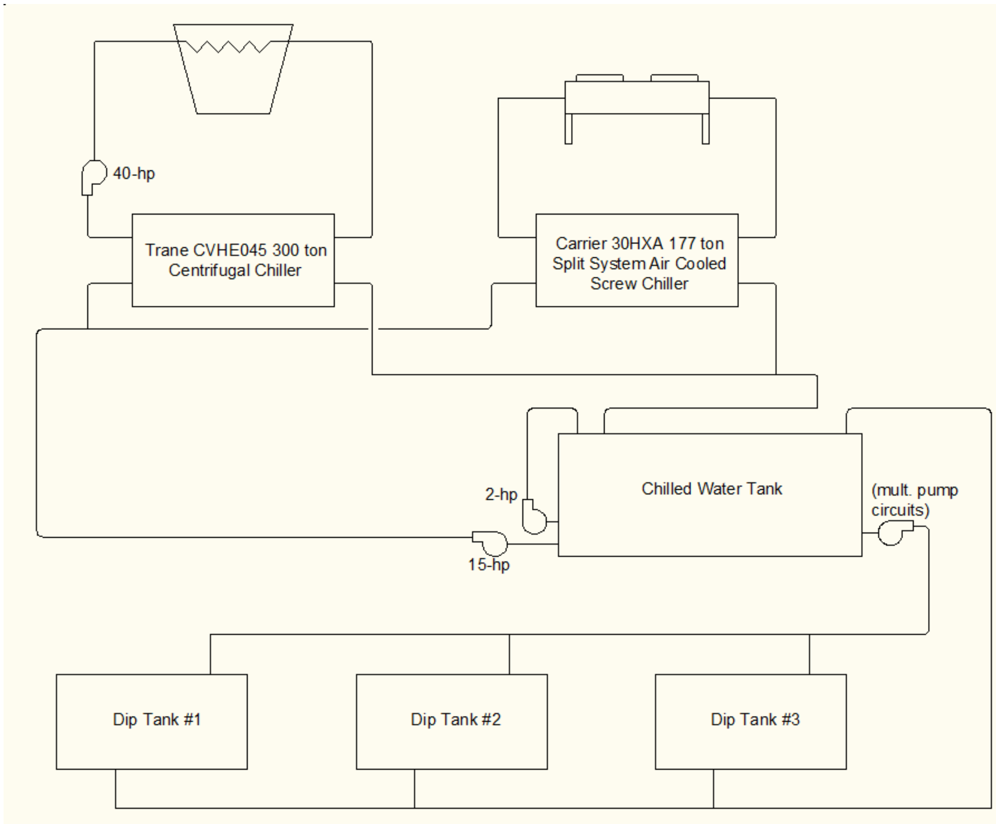

Figure 9: Wet Paint Chilled Water System Diagram

4.1.3 Chiller Performance Models

Chiller performance data for the chillers listed in Table 12 was obtained from the CoolTools™ Project Database. CoolTools™ is a program sponsored by Pacific Gas and Electric Company to increase the energy efficiency of chilled water plants within its service territory. Performance data for over 100 different chillers has been compiled from the four major chiller manufacturers.

Chiller performance is a function of entering condenser water temperatures (ECWT), leaving chilled water temperature (LCHWT) and part load ratio (PLR). Thus, three equations are used to describe the performance of the chiller across a range of operating conditions. The form of the equations is shown in EQ 1, EQ 3 and EQ 4. EQ 1 shows how the refrigeration capacity of the chiller varies with LCWHT and ECWT.

EQ 1: $CAP_{Ratio} = C_0 + C_1 \cdot LCHWT + C_2 \cdot LCHWT^2 + C_3 \cdot ECWT + C_4 \cdot ECWT^2 + C_5 \cdot LCHWT \cdot ECWT$

The part load ratio (PLR) of the chiller can then be found using EQ 2, where CAP_{Ref} is the capacity of the chiller at referenced conditions and Qload is the actual cooling load on the chiller.

EQ 2: $PLR = \frac{Q_{\text{Load}}}{CAP_{\text{Ratio}} \cdot CAP_{\text{Ref}}}$

The electric input ratio (EIR) of a chiller is the dimensionless ratio of input power to the useful cooling effect, or the inverse of the coefficient of the (COP). EQ 3 shows the EIR as a function of the LCHWT and ECWT.

EQ 3: $EIR_{TEMP} = ET_0 + ET_1 \cdot LCHWT + ET_2 \cdot LCHWT^2 + ET_3 \cdot ECWT + ET_4 \cdot ECWT^2 + ET_5 \cdot LCHWT \cdot ECWT$

The EIR of a chiller also varies with the PLR, and is shown in EQ 4.

EQ 4: $EIR_{PLR} = EP_0 + EP_1 \cdot PLR + EP_2 \cdot PLR^2$

The chiller input power can be estimated by multiplying the chiller power at reference conditions by the resulting EIR_{Temp} and EIR_{PLR} , as shown in **EQ 5.**

EQ 5: $P_{Actual} = P_{\text{Ref}} \cdot EIR_{\text{Temp}} \cdot \text{EIR}_{\text{PLR}}$

Using these relationships the efficiency of a chiller can be estimated across the range of anticipated operating conditions.

Chiller Performance Curves

4.1.3.1 Baseline 177-ton Air Cooled Screw Chiller

The coefficients for the Baseline air cooled screw chiller used for this analysis are shown in Table 14.

CAP_{RATIO}		EIR_{TEMP}		EIR_{PLR}	
a	0.670839910	a	0.93630582	a	0.25452350
b	0.002749410	b	-0.01015710	b	0.31049810
c	0.000181210	c	0.00021678	c	0.43477810
d	0.003261760	d	-0.00245357		
e	-0.000034430	e	0.00013577		
f	-0.000033900	f	-0.00021563		

Table 14: Baseline Chiller Performance Coefficients

Figure 10 shows a surface plot of the Baseline lead screw chiller's specific power input at a PLR of 1 and across the range of possible LCHWT and ECATs.

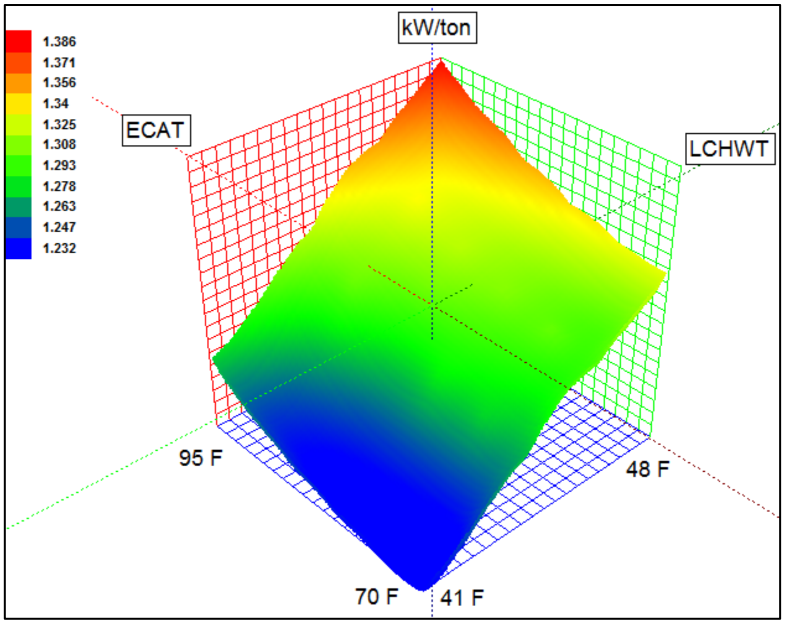

Figure 10: Baseline Chiller Power Surface Plot

It is evident, that the chiller specific power decreases at lower entering condenser air temperatures (ECATs) and at higher LCHWTs. These relationships are common to all chillers. However, the contour of the surface is dependent on the type of refrigerant and type of compressor and control strategy employed. PLR is the final variable that affects the specific power of a chiller. Figure 11 shows the part-load performance of the air cooled screw process chiller.

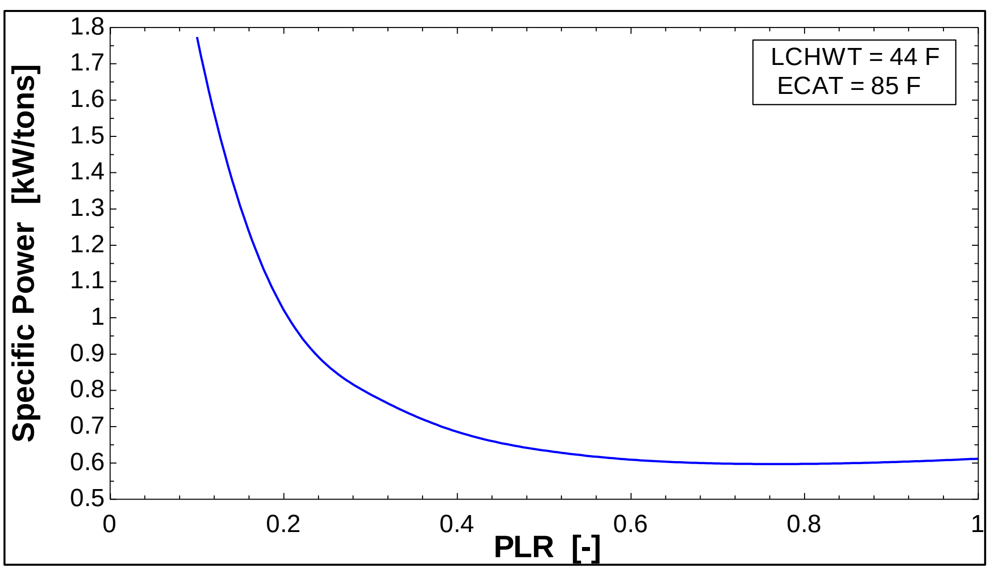

Figure 11: Baseline Screw Process Chiller Part-load Curve

The specific power starts at about 0.6 kW per ton when fully loaded. However, it steadily increases at lower loads until it reaches about 30% loaded when it sharply increases. The part load performance curve of different chillers may be considerably different due to the type of compressor and controls strategies employed.

4.1.3.2 New 300-ton Water Cooled Centrifugal Chiller

The coefficients for the new water cooled centrifugal chiller used for this analysis are shown in Table 15.

CAP_{RATIO}		EIR_{TEMP}		EIR_{PLR}	
a	0.400734100	a	0.62876460	a	0.09299787
b	0.001148568	b	-0.03024605	b	0.32444750
c	0.000104950	c	0.00061370	c	0.58187530
d	0.055746670	d	0.01805826		
e	-0.001646131	e	0.00016407		
f	0.001323200	f	-0.00011138		

Table 15: Proposed Chiller Performance Coefficients

Figure 12 shows a surface plot of the new centrifugal chiller's specific power input at a PLR of 1 and across the range of possible LCHWT and ECWTs.

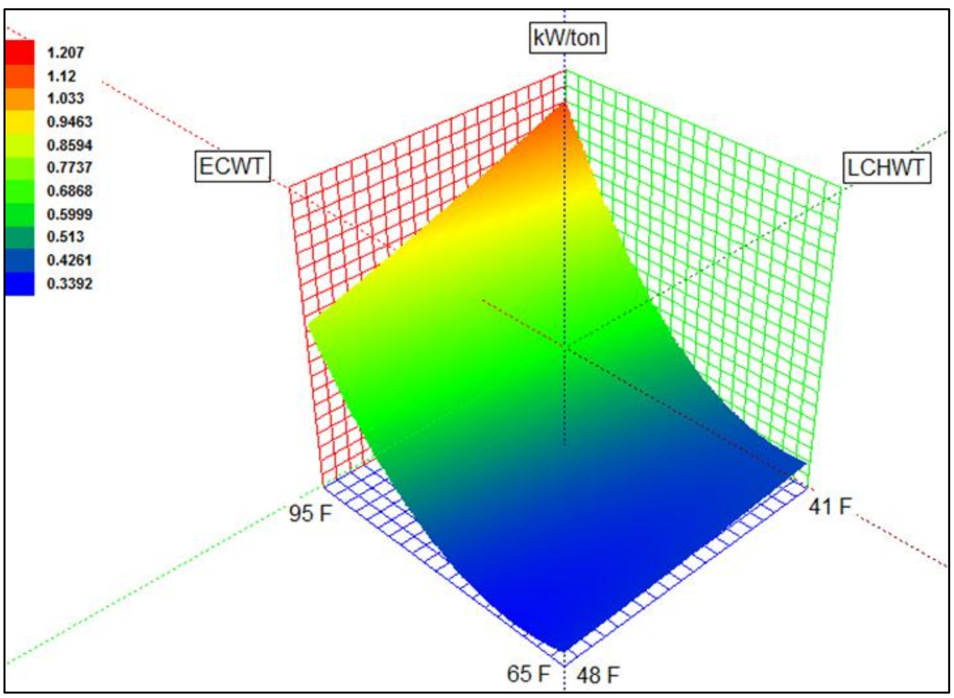

Figure 12: Chiller Power Surface Plot

It is evident, that the chiller specific power decreases at lower ECWTs and at higher LCHWTs. These relationships are common to all chillers. However, the contour of the surface is dependent on the type of refrigerant and type of compressor and control strategy employed. PLR is the final variable that affects the specific power of a chiller. Figure 13 shows the part-load performance of the centrifugal process chiller.

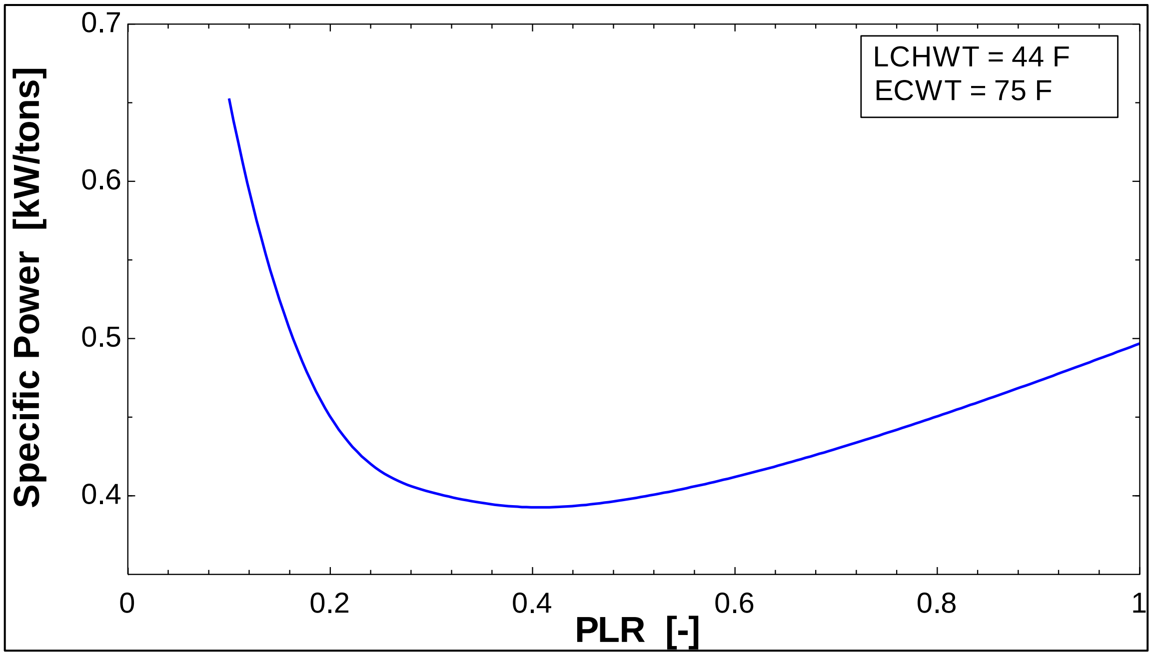

Figure 13: Centrifugal Process Chiller Part-load Curve

The specific power of the chiller is seen to be around 0.5 kW per ton when the chiller is fully loaded and reduces to a minimum of about 0.4 kW per ton around 40% loaded. The efficiency of the chiller sharply increases below 25% loading.

4.1.4 New Cooling Tower Performance Model

Kissock presents a regression model of cooling tower performance based on data from the ASHRAE Handbook, HVAC Systems and Equipment, 2004[1]. The resulting regression has an R^2 of 0.995 and is shown below.

$$\text{EQ 6: } Tc = a + b\,Twb + c\,Tr + d\,Twb^2 + e\,Tr^2 + f\,Tr\,Twb$$

Coefficient	Value
a	16.790751
b	0.6464308
c	2.2221763
d	0.0016061
e	0.0159268
f	-0.015954

Twb is the outdoor wetbulb temperature, and *Tr* is the cooling tower range, or temperature difference of the water condenser water, and *Tc* is the coldest water that the cooling tower can produce. A performance curve of the Evapco ESWA-216-45L closed circuit cooling tower was obtained from a manufacturer's representative and is shown in Figure 14.

[1] http://academic.udayton.edu/kissock/http/EEB/LecturesAndHomework/21-ChillersAndCoolingTowers/CoolingTowers.docx

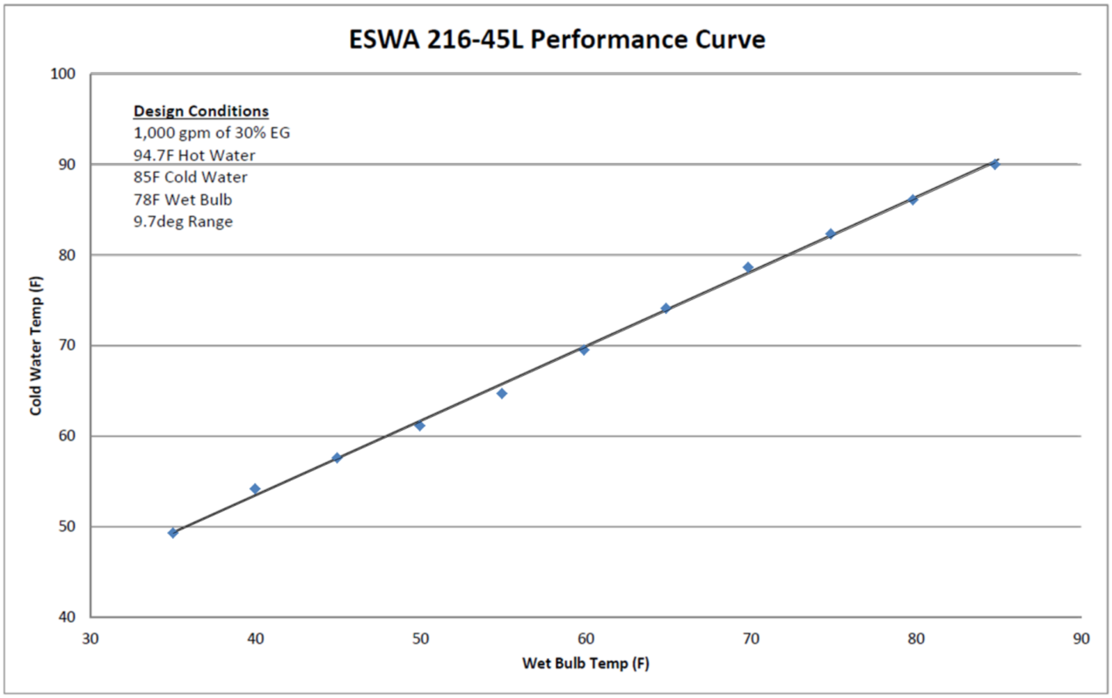

Figure 14: Cooling Tower Performance Curve

The cold water temperature was calculated at several wet-bulb temperatures. The resulting values were overlaid on the performance curve in Figure 14 and are seen to be in agreement with the performance curve.

4.2 Cooling Load Profile

The electrical waveform was observed to be a clean 60 HZ at the main feed upstream of the variable speed drive during our site visit. Thus, only electrical current was required to accurately log the power of the chiller. The New centrifugal chiller was logged for about a week and the data is shown in Figure 15.

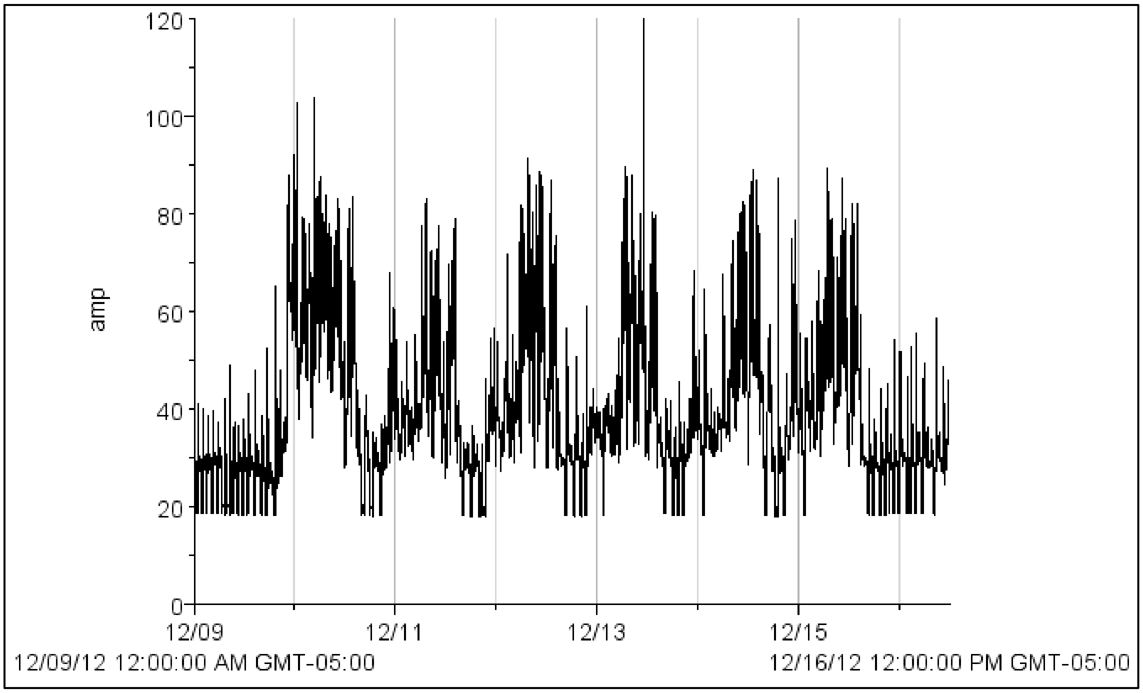

Figure 15: Logged Lead Chiller Data

The cooling load on the chiller can be estimated from the logged electrical data and the leaving chilled water and entering condenser water temperatures. The leaving chilled water temperature is equal to the chilled water temperature set-point or 44°F. The entering condenser water temperature varies with ambient conditions. A two day trend from the on-board controller, when ambient conditions were near freezing, can be seen in Figure 16.

Figure 16: Entering Condenser Water Temperature

The average is seen to be about 60°F during the period stored into the controller. The ambient conditions during our logging period were very similar with temperatures consistently near freezing. Thus, we assume that the average entering condenser water temperature during our logged period was about 60°F. The power input to the chiller holding the leaving chilled water and entering condenser temperatures constant was calculated across a range of chiller loading levels. Next, electrical current was calculated assuming 460 volts and a power factor of 0.95. The resulting model of chiller load as a function of electrical current is shown in Figure 17.

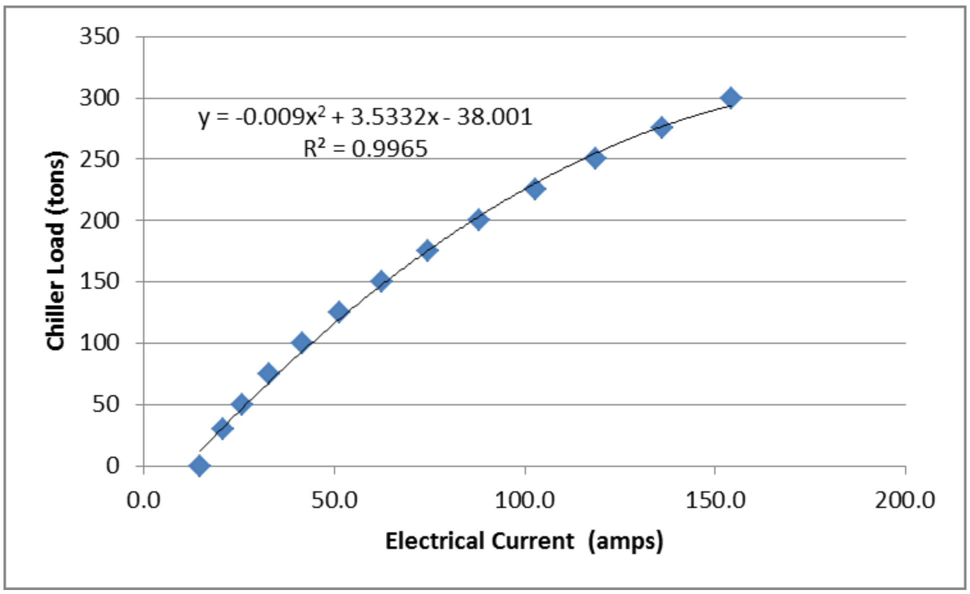

Figure 17: Chiller Load as a Function of Current

The equation shown in Figure 17 was used to estimate the chiller load from the logged electrical data. The estimated chiller load for the week of logged data is shown in Figure 18.

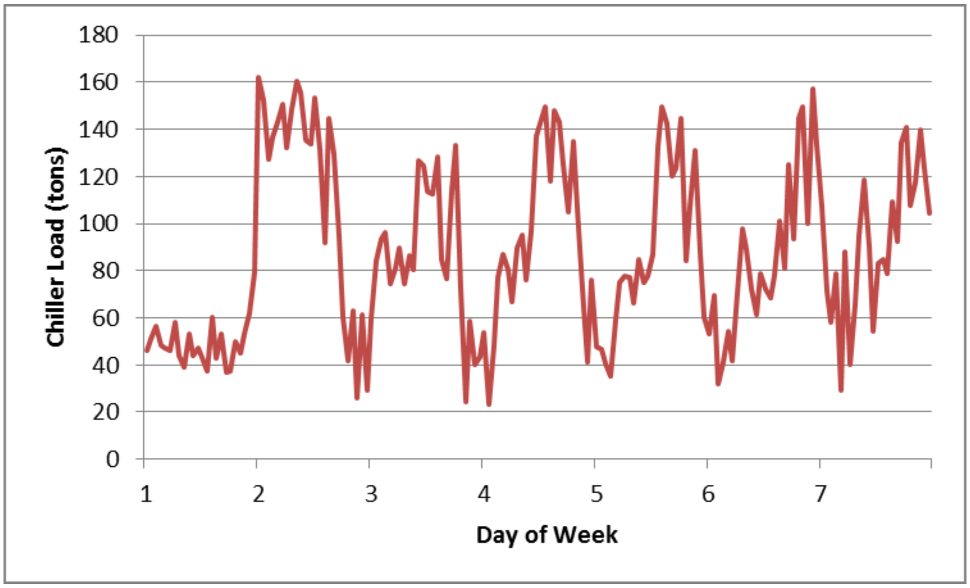

Figure 18: One Week Cooling Load Profile

This cooling load profile was assumed to be typical throughout the year since it is purely a process load and is not affected by ambient conditions. Energy savings between the Baseline and New chilled water systems were estimated using this cooling load profile in the following sections.

4.3 Simulation Algorithms

An hourly analysis was conducted to estimate the combined chiller and cooling tower energy consumption. TMY3 weather data for Columbus, OH was used to simulate typical ambient conditions at the plant. The cooling loads on each chiller were set on an hourly basis according to the loads and schedule previously discussed.

Estimating the combined power use of the chiller and cooling tower requires that a set of equations be solved simultaneously. This is because the power draw of the chiller is dependent on the temperature of the ECWT, and cooling tower performance is dependent on chiller loading and ambient conditions.

The power draw of each chiller is calculated using EQ 5. However, the ECWT is unknown and must be determined by modeling the cooling tower using EQ 6. Solving the cooling tower model will result in *Tc,* the coldest water that the cooling tower can produce. In practice, cooling towers are controlled to maintain a setpoint temperature by cycling the fan on and off or slowing the fan with a variable speed drive (VSD). Figure 19 shows the logic used to determine the ECWT from the cooling tower model and condenser water setpoint temperature, Tc,sp.

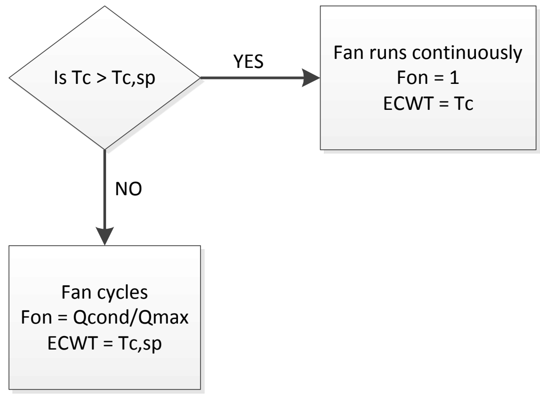

Figure 19: Fan Power Determination Logic

If the setpoint temperature is colder than the cooling tower can produce, the fans will run continuously and the ECWT will be equal to Tc. However, if the cooling tower can produce colder water than the setpoint, the fans will cycle to maintain Tc,sp and the ECWT will be equal to Tc,sp.

The temperature change across the condenser, Tr is equal to:

EQ 7: $Tr = Q_{cond}\,[Btu/hr] / (m_{cond}\,[gpm] \times 500\,[Btu/hr\text{-}gpm]$

Where m_{cond}, is the condenser water volume flow rate, and is estimated to be 900 gpm from the original chiller selection. Q_{cond} is the energy that is removed at the condenser of the chiller, which is equal to the work of the compressor and the cooling load:

EQ 8: $Q_{cond} = W_{comp} + CL \times 12{,}000\ Btu/hr\text{-}ton$

Where W_{comp} is the work of the compressor, which is equal to power input of the chiller.

EQ 9: $W_{comp} = P_{chiller} \times 3{,}412\,[Btu/kW]$

Chiller power draw and the cooling tower load are determined by iteratively solving these five equations and five unknowns. Cooling tower fan power draw is determined by estimating the fraction of time the fans need to operate, F_{on}. F_{on} is equal to the actual cooling tower load, Q_{cond} divided by the maximum cooling tower capacity.

$F_{on} = Q_{cond} / Q_{max}$

The cooling tower fan motor is assumed to be about 80% loaded and 90% efficient. Fan energy consumption with cycling controls and varying fan speed with a VFD are calculated using the following equations:

$P_{fan} = F_{on} \times Fan_{HP}\,[hp] \times 80\% / 90\% \times 0.75\ kW/hp$ *(cycling fan)*

$P_{fan} = (F_{on}/1)^3 \times Fan_{HP}\,[hp] \times 80\% / Eff_{motor} / Eff_{VFD} \times 0.75\ kW/hp$ *(VFD fan)*

Where, Eff_{motor} and Eff_{VFD} are the efficiencies of motors and VFDs respectively. The efficiency of motors and VFDs degrades at low part load ratios. Figure 20 shows motor and VFD efficiencies across the full range of motor loading and speeds.

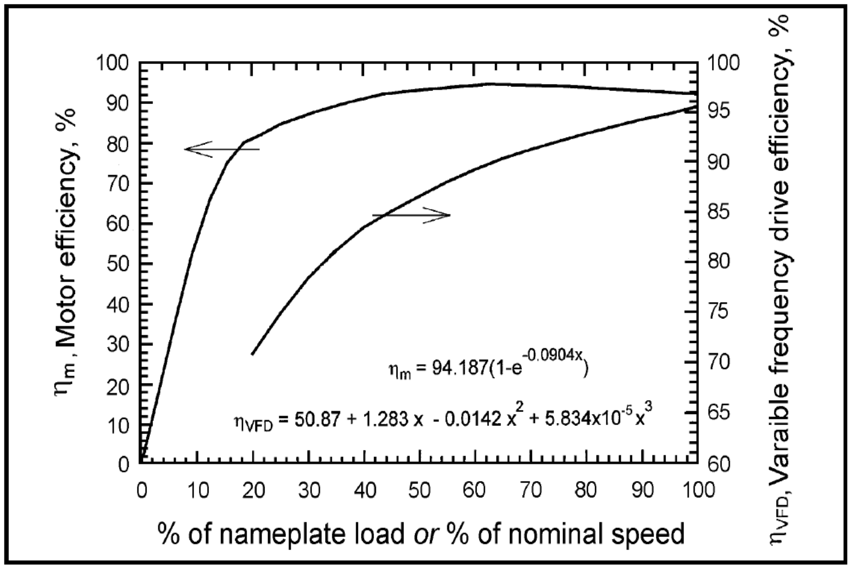

Figure 20: Motor and VFD Part-load Efficiency[2]

The efficiencies of the fan motor and VFD are calculated using the equations listed in Figure 20

The total chilled water system power is then equal to:

$P_{system} = P_{chiller} + P_{fan}$

4.4 Energy and Cost Savings Analysis

An hourly analysis was conducted to estimate the energy and cost savings from upgrading the chilled water system. This analysis was completed using the equipment performance models, simulation algorithms and cooling load profile previously developed. The simulations were run with Columbus, Ohio TMY3[3] weather data. A summary of the simulation results is presented below.

Simulation Results

First, the energy consumption of the Baseline chilled water system was simulated using the air cooled screw chiller performance parameters. Next, the energy consumption of the New chilled water system was simulated using the water cooled centrifugal chiller performance parameters. Figure 21 shows resulting monthly energy consumption (line graphs) and monthly peak demand (bar graphs) for both the Baseline and New chilled water systems.

[2] Bernier and Bourret, "Pumping Energy and Variable Frequency Drives" ASHRAE Journal December 1999

[3] Typical Meteorological Year 3 (TMY3) weather data: http://rredc.nrel.gov/solar/old_data/nsrdb/1991-2005/tmy3/

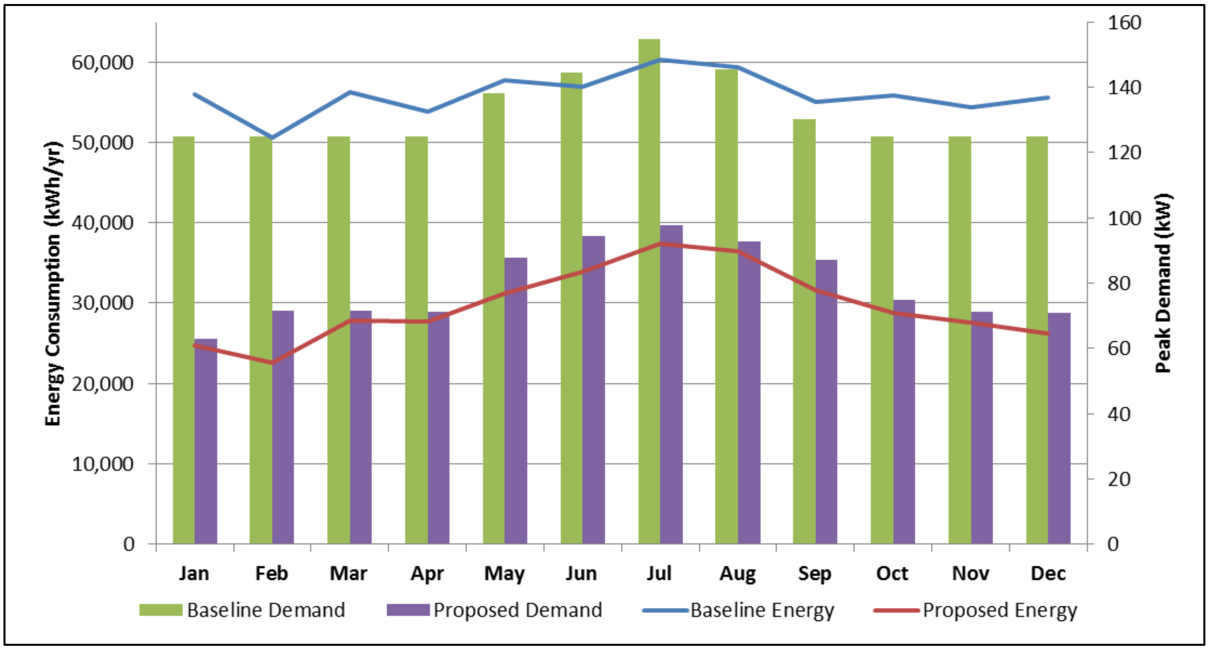

Figure 21: Monthly Energy and Demand

Table 16 shows a summary of the energy consumption of the Baseline and Proposed systems energy consumption. The total peak demand reductions and energy savings are increased by a factor of 1.04 to account for the two serial set-down transformers in the plant. This approach is discussed in detail in the Utility Analysis section of this report. Cost and CO_2 emissions savings are also shown.

	Baseline System		New System							
Month	Peak Demand (kW)	Energy (kWh/mo)	Peak Demand (kW)	Energy (kWh/mo)	Demand Savings (kW)	Energy Savings (kWh/mo)	Demand Cost Savings ($/mo)	Energy Cost Savings ($/mo)	Total Cost Savings ($/mo)	CO_2 Emissions Savings (lbs-CO_2/mo)
Jan	124.8	55,922	62.8	24,766	62.0	31,156	$121	$1,567	$1,688	76,644
Feb	124.8	50,599	71.4	22,547	53.4	28,052	$104	$1,411	$1,515	69,009
Mar	124.8	56,214	71.6	27,826	53.1	28,388	$104	$1,428	$1,532	69,834
Apr	124.8	53,787	71.2	27,733	53.6	26,054	$104	$1,311	$1,415	64,092
May	138.3	57,778	87.7	31,197	50.6	26,581	$99	$1,337	$1,436	65,390
Jun	144.4	56,950	94.3	33,915	50.1	23,036	$98	$1,159	$1,256	56,668
Jul	154.7	60,252	97.7	37,436	57.0	22,816	$111	$1,148	$1,259	56,127
Aug	145.3	59,369	92.8	36,452	52.5	22,917	$102	$1,153	$1,255	56,376
Sep	130.3	55,074	86.9	31,541	43.4	23,533	$85	$1,184	$1,268	57,891
Oct	124.8	55,920	74.9	28,805	49.8	27,115	$97	$1,364	$1,461	66,704
Nov	124.8	54,325	71.3	27,534	53.5	26,791	$104	$1,348	$1,452	65,907
Dec	124.8	55,522	70.9	26,220	53.9	29,303	$105	$1,474	$1,579	72,084
Total/Avg.	**132.2**	**671,714**	**79.5**	**355,972**	**52.7**	**315,742**	**$1,234**	**$15,882**	**$17,116**	**776,725**

Table 16: Energy Savings Summary

5 Appendix A – Logged Data

We placed data loggers throughout the facility to collect electrical current data and compressed air pressure. The following sections present the data gathered and any findings we may have derived from the data.

5.1 Logged Air Compressor #1 Data

We logged the #1 air compressor's electrical current. Figure 22 shows the logged electrical current of the 500-hp air compressor. It is seen that the compressor operates continuously, except for a short period Saturday night.

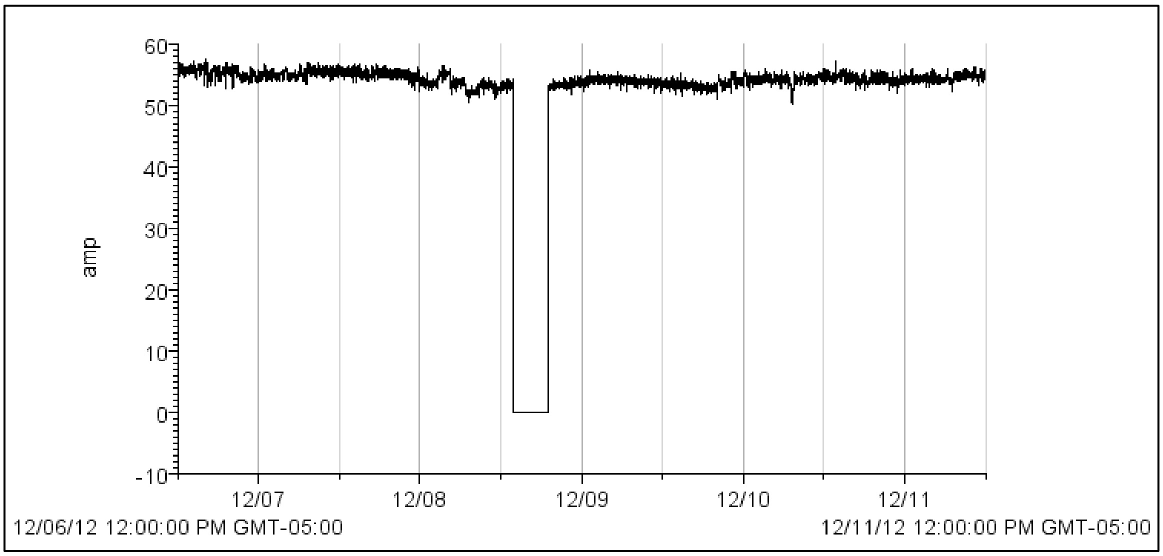

Figure 22: #1 Air Compressor Logged Current

5.2 Logged Air Compressor #2 Data

We logged the #2 air compressor's electrical current. Figure 23 shows the logged electrical current of the 450-hp air compressor. It is seen that the compressor operates for only a short time on Saturday and is restarted Monday morning.

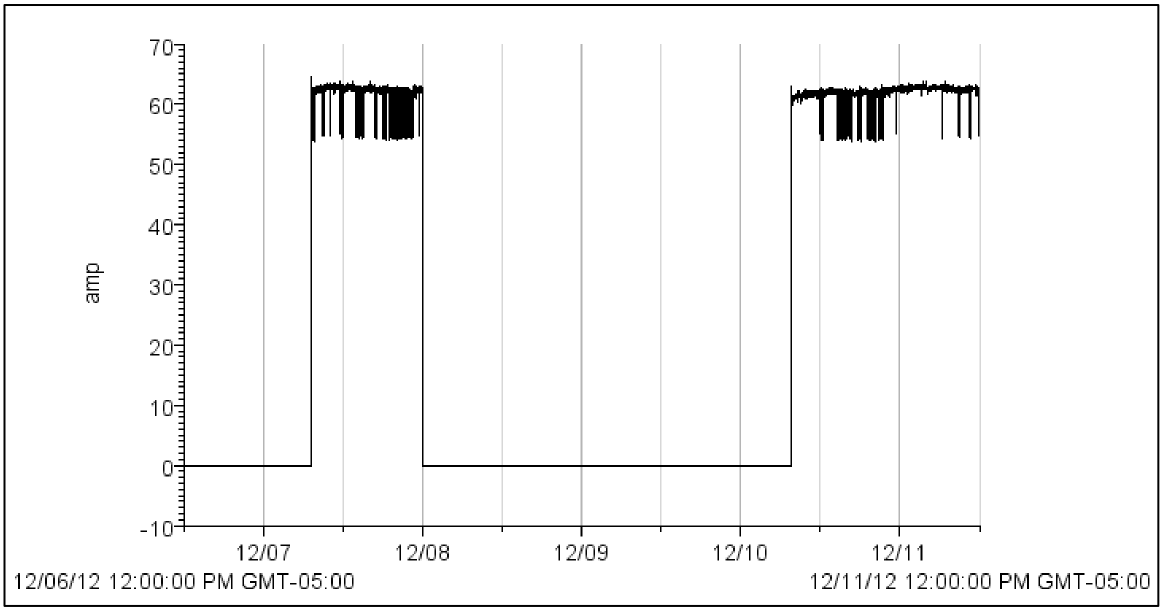

Figure 23: #2 Air Compressor Logged Current

5.3 Logged Air Compressor #3 Data

We logged the #3 air compressor's electrical current. Figure 24 shows the logged electrical current of the 450-hp air compressor. It is seen that the compressor operates intermittently.

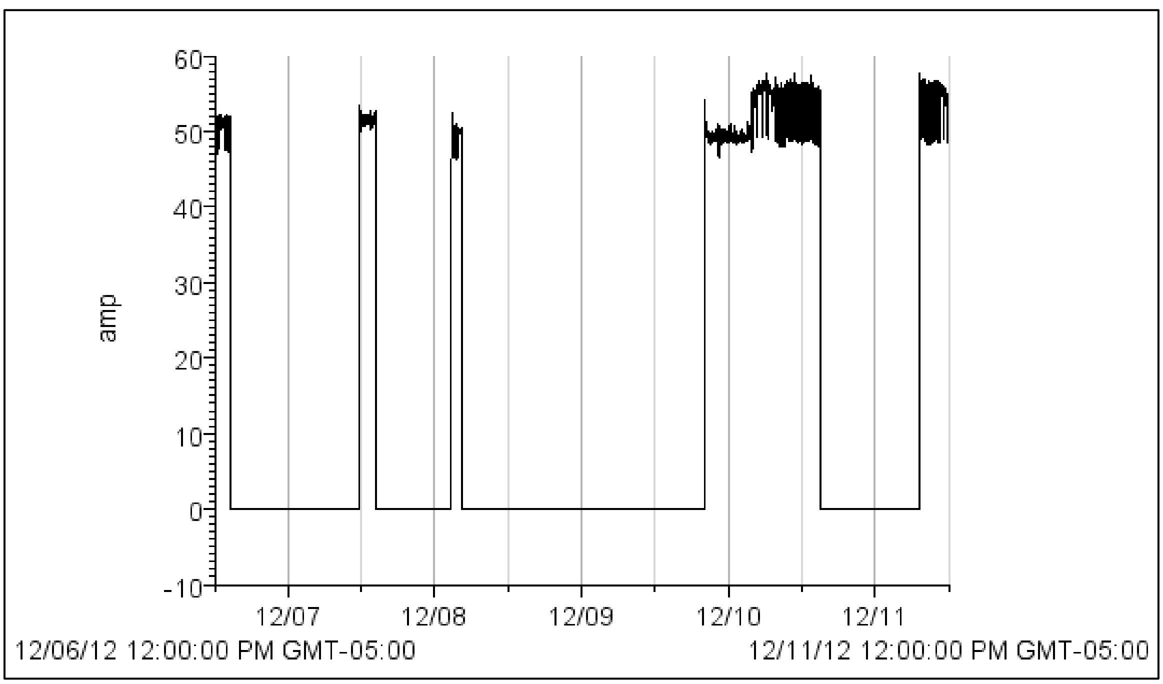

Figure 24: #3 Air Compressor Logged Current

5.4 Logged Air Compressor #4 Data

We logged the #4 air compressor's electrical current. Figure 25 shows the logged electrical current of the 450-hp air compressor. The data starting on 12/9/12 does not resemble a typical compressor power profile. Furthermore the amperage readings are well above the maximum operating amperage of the compressor. Thus, we have deemed the logged data values after 12/9/12 unreliable. However, we assume the logged data after 12/9/12 accurately depicts if the compressor was operating. The current draws on 12/6 and 12/7 were fairly constant. Thus, we assume the compressor drew the average current draw from the reliable data period while operating after 12/9/12.

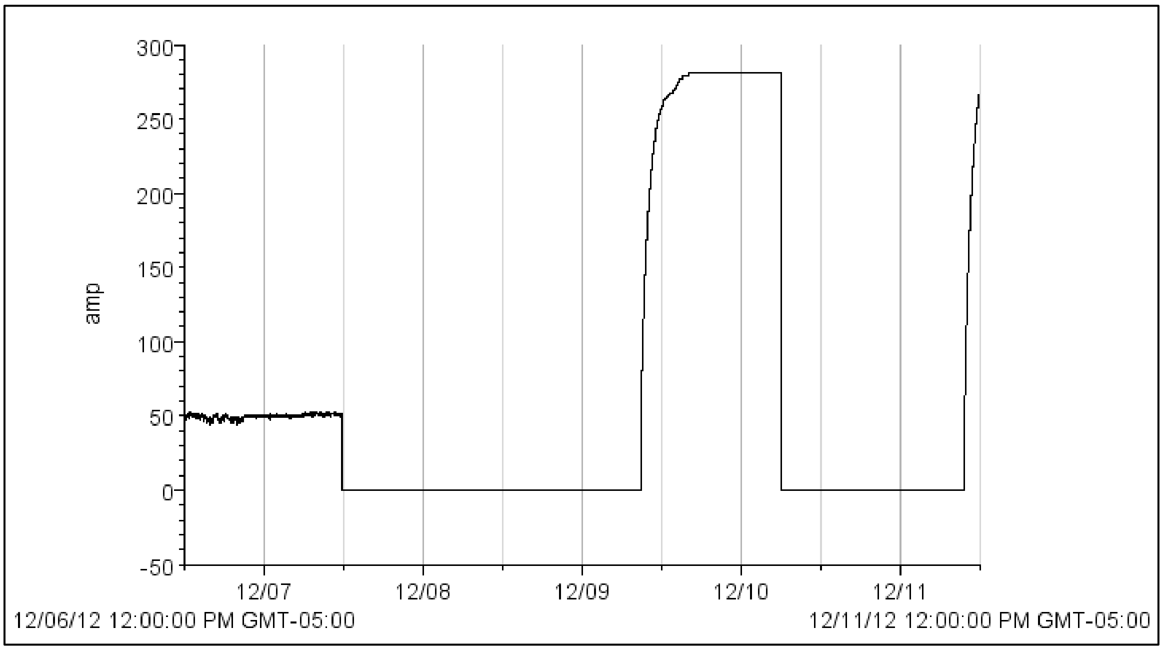

Figure 25: #4 Air Compressor Logged Current

5.5 Logged Air Compressor #5 Data

We logged the #5 air compressor's electrical current. Figure 26 shows the logged electrical current of the 200-hp air compressor. It is seen that the compressor operates intermittently.

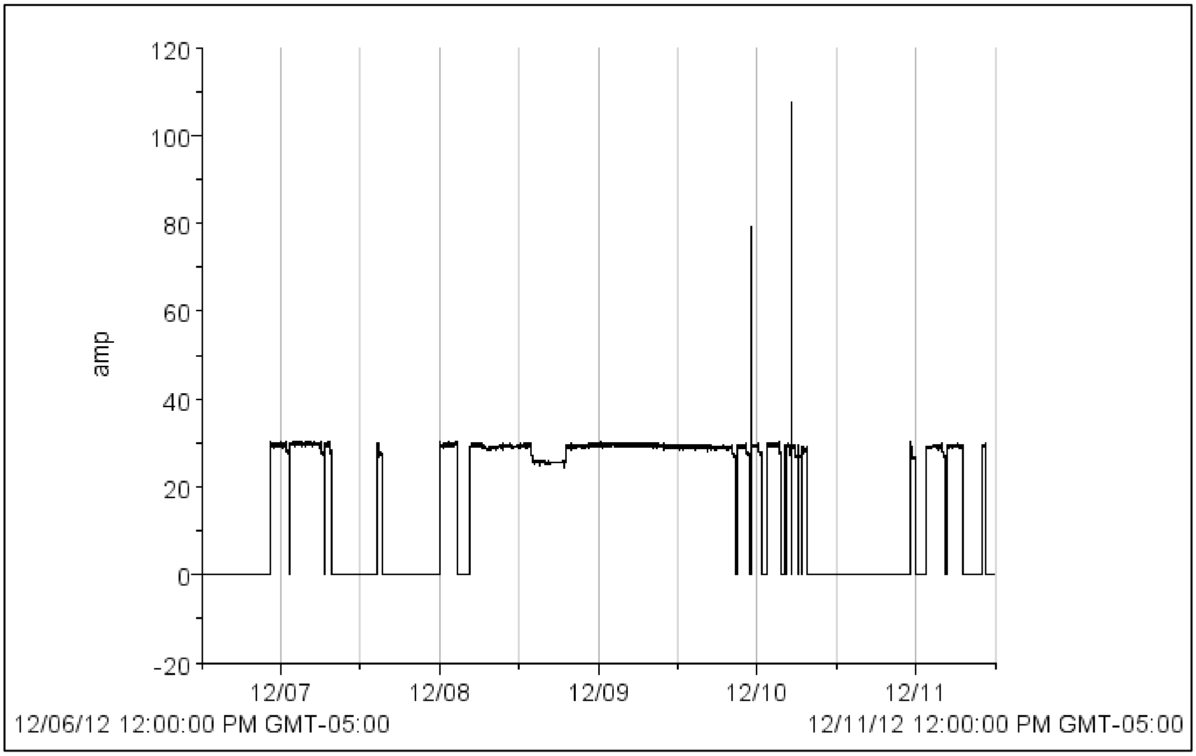

Figure 26: #5 Air Compressor Logged Current

5.6 Logged Air Compressor #6 Data

We logged the #6 air compressor's electrical current. Figure 27 shows the logged electrical current of the 200-hp air compressor.

The amperage draw for compressor #6 is an accurate profile, but is not measured to the correct scale. We scaled up compressor #6's logged amperage draws so that the peak draws matched the scale of compressor #5's peak draws, which is an identical compressor. The compressor is seen to operate intermittently.

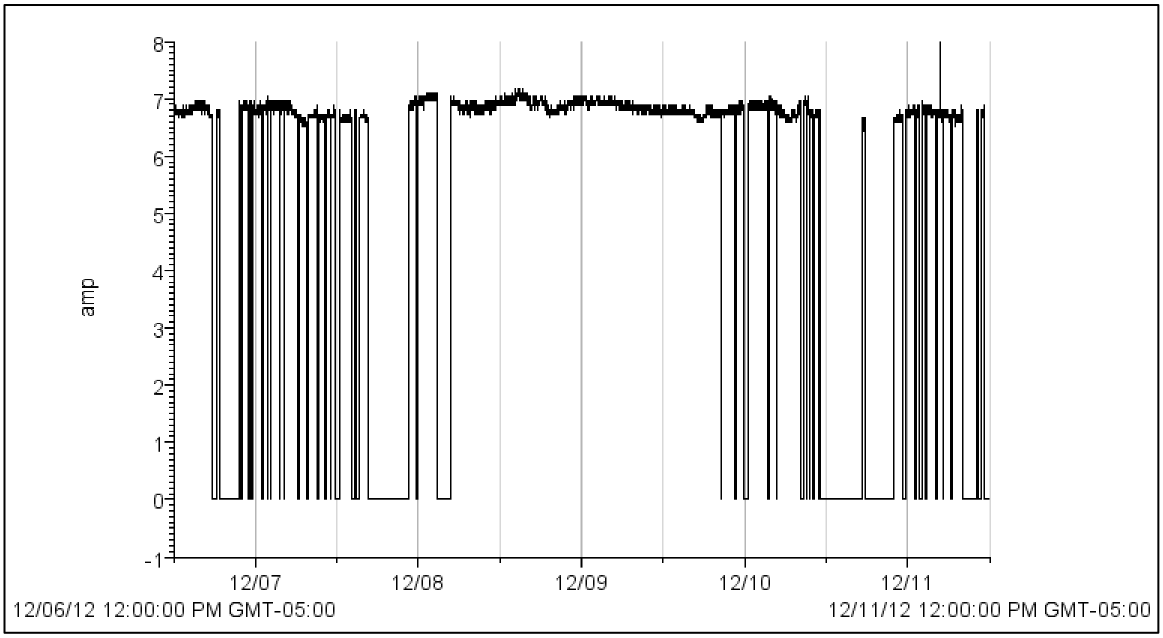

Figure 27: #6 Air Compressor Logged Current

5.7 Logged Air Compressor #7 Data

We logged the #7 air compressor's electrical current. Figure 28 shows the logged electrical current of the 450-hp air compressor. It is seen that the compressor operates continuously on the weekdays and is off for the weekend.

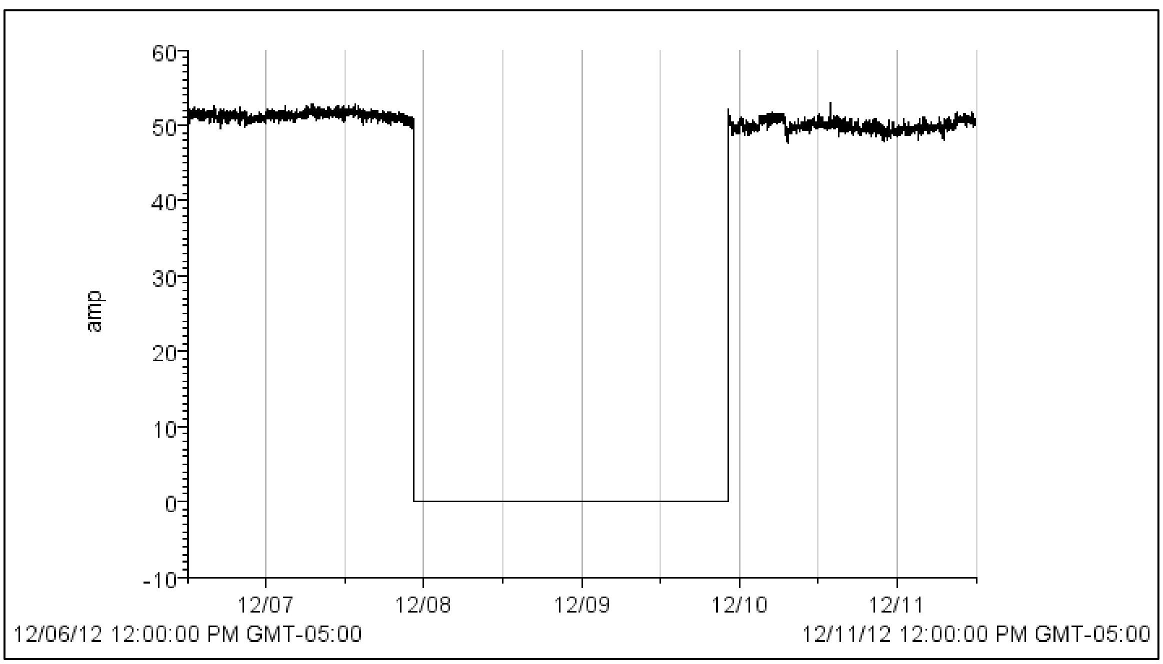

Figure 28: #7 Air Compressor Logged Current

5.8 Logged Compressed Air System Pressure

We logged the compressed air system pressure at the main compressor room. Figure 29 shows the logged air pressure. It is seen that the compressed air pressure is on average about 95 psig.

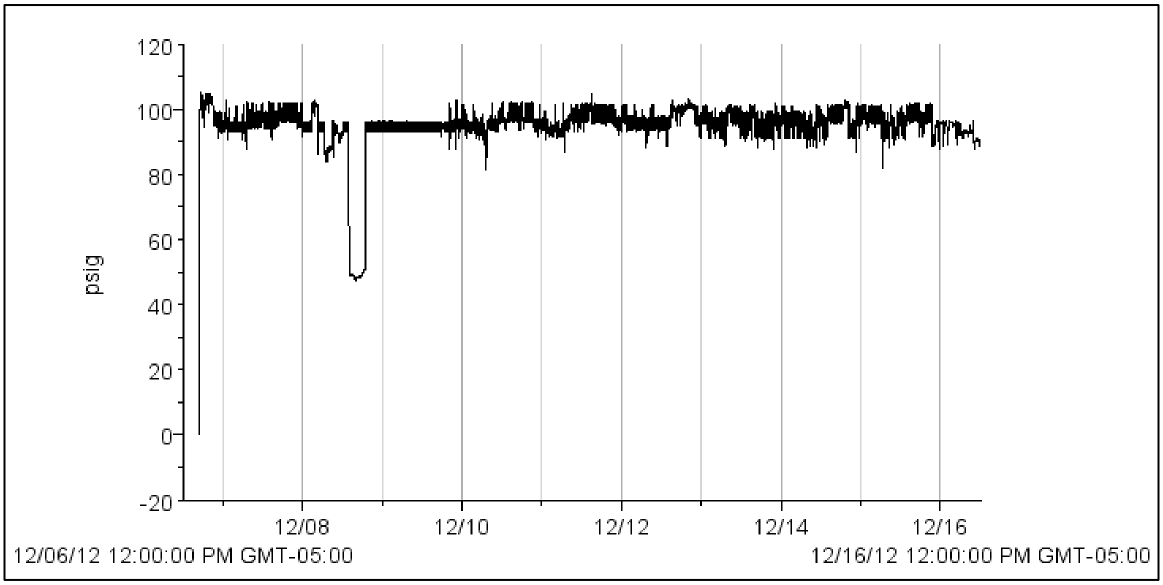

Figure 29: Compressed Air Pressure

5.9 Wet Paint Centrifugal Chiller

We logged the Wet Paint centrifugal chiller's electrical current. Figure 30 shows the logged electrical current of the 300-ton chiller. It is seen that the chiller operates continuously at varying loads.

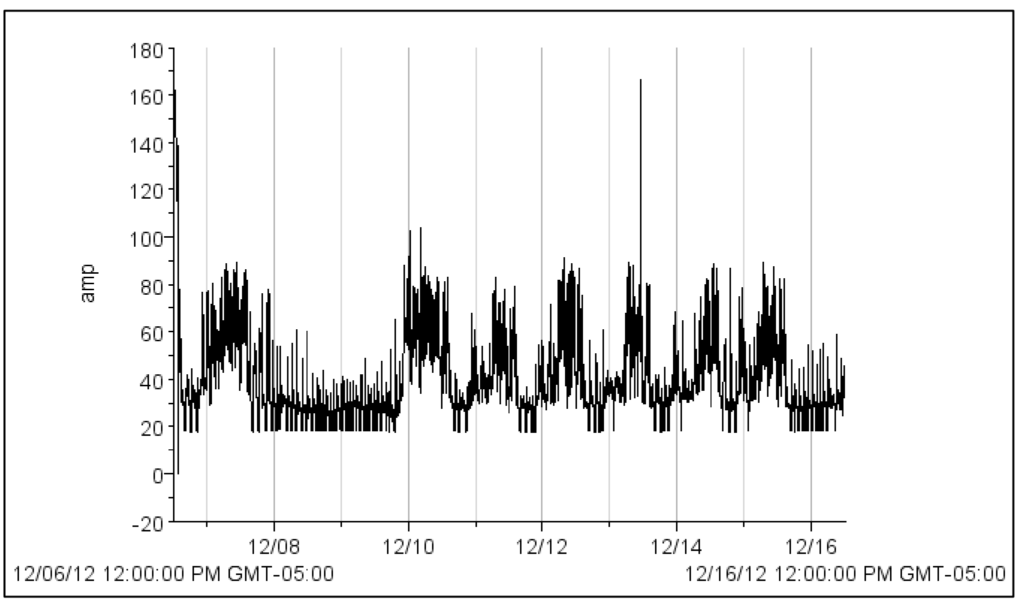

Figure 30: Wet Paint Centrifugal Chiller Logged Current

Mercantile Customer Project Commitment Agreement
Cash Rebate Option

THIS MERCANTILE CUSTOMER PROJECT COMMITMENT AGREEMENT ("Agreement") is made and entered into by and between Ohio Edison Company, its successors and assigns (hereinafter called the "Company") and Whirlpool Corporation, Taxpayer ID No. 381490038 its permitted successors and assigns (hereinafter called the "Customer") (collectively the "Parties" or individually the "Party") and is effective on the date last executed by the Parties as indicated below.

WITNESSETH

WHEREAS, the Company is an electric distribution utility and electric light company, as both of these terms are defined in R.C. § 4928.01(A); and

WHEREAS, Customer is a mercantile customer, as that term is defined in R.C. § 4928.01(A)(19), doing business within the Company's certified service territory; and

WHEREAS, R.C. § 4928.66 (the "Statute") requires the Company to meet certain energy efficiency and peak demand reduction ("EE&PDR") benchmarks; and

WHEREAS, when complying with certain EE&PDR benchmarks the Company may include the effects of mercantile customer-sited EE&PDR projects; and

WHEREAS, Customer has certain customer-sited demand reduction, demand response, or energy efficiency project(s) as set forth in attached Exhibit 1 (the "Customer Energy Project(s)") that it desires to commit to the Company for integration into the Company's Energy Efficiency & Peak Demand Reduction Program Portfolio Plan ("Company Plan") that the Company will implement in order to comply with the Statute; and

WHEREAS, the Customer, pursuant to the Public Utilities Commission of Ohio's ("Commission") September 15, 2010 Order in Case No. 10-834-EL-EEC, desires to pursue a cash rebate of some of the costs pertaining to its Customer Energy Project(s) ("Cash Rebate") and is committing the Customer Energy Project(s) as a result of such incentive.

WHEREAS, Customer's decision to commit its Customer Energy Project(s) to the Company for inclusion in the Company Plan has been reasonably encouraged by the possibility of a Cash Rebate.

WHEREAS, in consideration of, and upon receipt of, said cash rebate, Customer will commit the Customer Energy Project(s) to the Company and will comply with all other terms and conditions set forth herein.

NOW THEREFORE, in consideration of the mutual promises set forth herein, and for other good and valuable consideration, the receipt and sufficiency of which is hereby acknowledged, the parties, intending to be legally bound, do hereby agree as follows:

1. **Customer Energy Projects.** Customer hereby commits to the Company and Company accepts for integration into the Company Plan the Customer Energy Project(s) set forth on attached Exhibit 1. Said commitment shall be for the life of the Customer Energy Project(s). Company will incorporate said project(s) into the Company Plan to the extent that such projects qualify. In so committing, and as evidenced by the affidavit attached hereto as Exhibit A, Customer acknowledges that the information provided to the Company about the Customer Energy Project(s) is true and accurate to the best of its knowledge.

a. By committing the Customer Energy Project(s) to the Company, Customer acknowledges and agrees that the Company shall control the use of the kWh and/or kW reductions resulting from said projects for purposes of complying with the Statute. By committing the Customer Energy Project(s), Customer further acknowledges and agrees that the Company shall take ownership of the energy efficiency capacity rights associated with said Project(s) and shall, at its sole discretion, aggregate said capacity into the PJM market through an auction. Any proceeds from any such bids accepted by PJM will be used to offset the costs charged to the Customer and other of the Company's customers for compliance with state mandated energy efficiency and/or peak demand requirements

b. The Company acknowledges that some of Customer's Energy Projects contemplated in this paragraph may have been performed under certain other federal and/or state programs in which certain parameters are required to be maintained in order to retain preferential financing or other government benefits (individually and collectively, as appropriate, "Benefits"). In the event that the use of any such project by the Company in any way affects such Benefits, and upon written request from the Customer, Company will release said Customer's Energy Project(s) to the extent necessary for Customer to meet the prerequisites for such Benefits. Customer acknowledges that such release (i) may affect Customer's cash rebate discussed in Article 3 below; and (ii) will not affect any of Customer's other requirements or obligations.

c. Any future Customer Energy Project(s) committed by Customer shall be subject to a separate application and, upon approval by the Commission, said projects shall become part of this Agreement.

d. Customer will provide Company or Company's agent(s) with reasonable assistance in the preparation of the Commission's standard joint application for approval of this Agreement ("Joint Application") that will be filed with the Commission, with such Joint Application being consistent with then current Commission requirements.

e. Upon written request and reasonable advance notice, Customer will grant employees or authorized agents of either the Company or the Commission reasonable, pre-arranged access to the Customer Energy Project(s) for purposes of measuring and verifying energy savings and/or peak demand reductions resulting from the Customer Energy Project(s). It is expressly agreed that consultants of either the Company or the Commission are their respective authorized agents.

2. **Joint Application to the Commission.** The Parties will submit the Joint Application using the Commission's standard "Application to Commit Energy Efficiency/Peak Demand Reduction Programs" ("Joint Application") in which they will seek the Commission's approval of (i) this Agreement; (ii) the commitment of the Customer Energy Project(s) for inclusion in the Company Plan; and (iii) the Customer's Cash Rebate.

   The Joint Application shall include all information as set forth in the Commission's standard form which, includes without limitation:

   i. A narrative description of the Customer Energy Project(s), including but not limited to, make, model and year of any installed and/or replaced equipment;
   ii. A copy of this Agreement; and
   iii. A description of all methodologies, protocols, and practices used or proposed to be used in measuring and verifying program results.

3. **Customer Cash Rebate.** Upon Commission approval of the Joint Application, Customer shall provide Company with a W-9 tax form, which shall at a minimum include Customer's tax identification number. Within the greater of 90 days of the Commission's approval of the Joint Application or the completion of the Customer Energy Project, the Company will issue to the Customer the Cash Rebate in the amount set forth in the Commission's Finding and Order approving the Joint Application.

   a. Customer acknowledges: i) that the Company will cap the Cash Rebate at the lesser of 50% of Customer Energy Project(s) costs or $250,000; ii) the maximum rebate that the Customer may receive per year is $500,000 per Taxpayer Identification Number per utility service territory; and iii) if the Customer Energy Project qualifies for a rebate program approved by the Commission and offered by the Company, Customer may still elect to file such project under the Company's mercantile customer self direct program, however the Cash Rebate that will be paid shall be discounted by 25%; and

   b. Customer acknowledges that breaches of this Agreement, include, but are not limited to:

      i. Customer's failure to comply with the terms and conditions set forth in the Agreement, or its equivalent, within a reasonable period of time after receipt of written notice of such non-compliance;

      ii. Customer knowingly falsifying any documents provided to the Company or the Commission in connection with this Agreement or the Joint Application.

   c. In the event of a breach of this Agreement by the Customer, Customer agrees and acknowledges that it will repay to the Company, within 90 days of receipt of written notice of said breach, the full amount of the Cash Rebate paid under this Agreement. This remedy is in addition to any and all other remedies available to the Company by law or equity.

4. **Termination of Agreement.** This Agreement shall automatically terminate:

   a. If the Commission fails to approve the Joint Agreement;

   b. Upon order of the Commission; or

   c. At the end of the life of the last Customer Energy Project subject to this Agreement.

   Customer shall also have an option to terminate this Agreement should the Commission not approve the Customer's Cash Rebate, provided that Customer provides the Company with written notice of such termination within ten days of either the Commission issuing a final appealable order or the Ohio Supreme Court issuing its opinion should the matter be appealed.

5. **Confidentiality.** Each Party shall hold in confidence and not release or disclose to any person any document or information furnished by the other Party in connection with this Agreement that is designated as confidential and proprietary ("Confidential Information"), unless: (i) compelled to disclose such document or information by judicial, regulatory or administrative process or other provisions of law; (ii) such document or information is generally available to the public; or (iii) such document or information was available to the receiving Party on a non-confidential basis at the time of disclosure.

   a. Notwithstanding the above, a Party may disclose to its employees, directors, attorneys, consultants and agents all documents and information furnished by the other Party in connection with this Agreement, provided that such employees, directors, attorneys, consultants and agents have been advised of the confidential nature of this information and through such disclosure are deemed to be bound by the terms set forth herein.

b. A Party receiving such Confidential Information shall protect it with the same standard of care as its own confidential or proprietary information.

c. A Party receiving notice or otherwise concluding that Confidential Information furnished by the other Party in connection with this Agreement is being sought under any provision of law, to the extent it is permitted to do so under any applicable law, shall endeavor to: (i) promptly notify the other Party; and (ii) use reasonable efforts in cooperation with the other Party to seek confidential treatment of such Confidential Information, including without limitation, the filing of such information under a valid protective order.

d. By executing this Agreement, Customer hereby acknowledges and agrees that Company may disclose to the Commission or its Staff any and all Customer information, including Confidential Information, related to a Customer Energy Project, provided that Company uses reasonable efforts to seek confidential treatment of the same.

6. **Taxes.** Customer shall be responsible for all tax consequences (if any) arising from the payment of the Cash Rebate.

7. **Notices.** Unless otherwise stated herein, all notices, demands or requests required or permitted under this Agreement must be in writing and must be delivered or sent by overnight express mail, courier service, electronic mail or facsimile transmission addressed as follows:

If to the Company:

FirstEnergy Service Company
76 South Main Street
Akron, OH 44308
Attn: Victoria Nofziger
Telephone: 330-384-4684
Fax: 330-761-4281
Email: vmnofziger@firstenergycorp.com

If to the Customer:

Whirlpool Corporation
1300 Marion-Agosta Rd
Marion, Ohio 43302
Attn:David Freyhof
Telephone: 740-383-7188
Fax:740-383-7535
Email:david_a_freyhof@whirlpool.com

or to such other person at such other address as a Party may designate by like notice to the other Party. Notice received after the close of the business day will be deemed received on the next business day; provided that notice by facsimile transmission will be deemed to have been received by the recipient if the recipient confirms receipt telephonically or in writing.

8. **Authority to Act.** The Parties represent and warrant that they are represented by counsel in connection with this Agreement, have been fully advised in connection with the execution thereof, have taken all legal and corporate steps necessary to enter into this Agreement, and that the undersigned has the authority to enter into this Agreement, to bind the Parties to all provisions herein and to take the actions required to be performed in fulfillment of the undertakings contained herein.

9. **Non-Waiver.** The delay or failure of either party to assert or enforce in any instance strict performance of any of the terms of this Agreement or to exercise any rights hereunder conferred, shall not be construed as a waiver or relinquishment to any extent of its rights to assert or rely upon such terms or rights at any later time or on any future occasion.

10. **Entire Agreement.** This Agreement, along with related exhibits, and the Company's Rider DSE, or its equivalent, as amended from time to time by the Commission, contains the Parties' entire understanding with respect to the matters addressed herein and there are no verbal or collateral representations, undertakings, or agreements not expressly set forth herein. No change in, addition to, or waiver of the terms of this Agreement shall be binding upon any of the Parties unless the same is set forth in writing and signed by an authorized representative of each of the Parties. In the event of any conflict between Rider DSE or its equivalent and this document, the latter shall prevail.

11. **Assignment.** Customer may not assign any of its rights or obligations under this Agreement without obtaining the prior written consent of the Company, which consent will not be unreasonably withheld. No assignment of this Agreement will relieve the assigning Party of any of its obligations under this Agreement until such obligations have been assumed by the assignee and all necessary consents have been obtained.

12. **Severability.** If any portion of this Agreement is held invalid, the Parties agree that such invalidity shall not affect the validity of the remaining portions of this Agreement, and the Parties further agree to substitute for the invalid portion a valid provision that most closely approximates the economic effect and intent of the invalid provision.

13. **Governing Law.** This Agreement shall be governed by the laws and regulations of the State of Ohio, without regard to its conflict of law provisions.

14. **Execution and Counterparts.** This Agreement may be executed in multiple counterparts, which taken together shall constitute an original without the necessity of all parties signing the same page or the same documents, and may be executed by signatures to electronically or telephonically transmitted counterparts in lieu of original printed or photocopied documents. Signatures transmitted by facsimile shall be considered original signatures.

IN WITNESS WHEREOF, the Parties hereto have caused this Agreement to be executed by their duly authorized officers or representatives as of the day and year set forth below.

Ohio Edison Company_
(Company)

By: [signature]

Title: V.P. Of Energy Efficiency

Date: 8-2-13

Whirlpool Corporation
(Customer)

By: [signature]

Title: 6/12/13

Date: 6/12/13

Version 9.11.12

Affidavit of Whirlpool Corporation - Exhibit _A

STATE OF OHIO)
) SS:
COUNTY OF Marion)

I, Tim Anderson ,being first duly sworn in accordance with law, deposes and states as follows:

1. I am the Controller of Whirlpool Corporation ("Customer") As part of my duties, I oversee energy related matters for the Customer.
2. The Customer has agreed to commit certain energy efficiency projects to Ohio Edison Company ("Company"), which are the subject of the agreement to which this affidavit is attached ("Project(s)").
3. In exchange for making such a commitment, the Company has agreed to provide Customer with Cash ("Incentive"). This Incentive was a critical factor in the Customer's decision to go forward with the Project(s) and to commit the Project(s) to the Company.
4. All information related to said Project(s) that has been submitted to the Company is true and accurate to the best of my knowledge.

FURTHER AFFIANT SAYETH NAUGHT.

6/12/13

Sworn to before me and subscribed in my presence this 12 day of June, 2013

Barbara A Gosher
Notary

B[illegible]
Notary Pub[illegible] State of Ohio
My Commission Ex[illegible] 4-17-2017